Integration of Strategic Environmental Assessment into Watershed Management in China: Necessity, Implementation and Challenges

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ABSTRACT

This study aims to develop a context-specific SEA (strategic environmental assessment) framework and an indicator sysmtem for watershed management in China and they hope to be used in practical watershed-PEIAs (Plan-EIA, environmental impact assessment for plans, the prevalent SEA type in China). Particularly, the indicator system and CEA (cumulative effect assessment) specific to watershed-SEAs were systematically analyzed and discussed. In addition, the necessity of watershed-PEIAs and the status of watershed-based SEAs need to be analyzed and discussed, especially the main obstacles limiting and affecting the watershed-PEIA process, conclusions and its integration with watershed management plans.

Before the study, review of theories about SEA, Watershed management and Watershed-PEIAs across the world were undertaken to find out the research gaps and obtain the theoretical support. Moreover, associated data and cases were collected for analyzing the status of watershed-PEIAs, especially the main problems in the legislative, institutional, cultural and technical aspects.

The research focuses on the performance of watershed-based SEAs. Development of 'Overall Effectiveness Criteria' and analyses of associated SEA themes with effectiveness, discussion of the main challenges limiting effective implementation of watershed-PEIAs and effectiveness evaluation of the selected cases and the development of the watershed-based SEA framework for improving effectiveness are integrated and they form a framework of environmental considerations into watershed management.

All these findings are expected to provide valuable reference for maximizing effective linkage between SEA and watershed management under current contexts or under continuously improved contexts, so as to ultimately achieve China's sustainable watershed management. The research will also pave the way and

providing a step stone for future studies on the aforementioned research priorities, especially CEA of watershed developments and indicators for assessing environmental potentials of watershed developments.

摘要

該研究旨在制定適合中國制度背景和技術水準的流域管理戰略環境評價框架及其指標體系，將其用於我國的流域規劃環評實踐（規劃環評是當前中國最主要的戰略環評形式）。其中，對流域管理的環評指標體系及其累積影響評價進行了係統分析和討論，並提出相關建議和方法。另外，需要明確流域規劃環評的必要性，並分析和討論中國流域規劃環評的實施現狀，找出限制流域規劃環評的主要障礙和挑戰。

爲了實現該研究的主要目標，首先對戰略環境影響評價、流域管理及流域規劃環評的進展進行了分析和評價，並找出研究中存在的主要問題，爲該研究提供理論基礎；另外，搜集了相關的資料和案例，並結合問卷和走訪等調研結果，分析流域規劃環評的現狀，尤其是從立法、制度和文化背景方面和技術方面分析了阻礙流域規劃環評有效實施的主要問題。

該研究實際上是圍繞流域管理環境影響評價的有效性展開的，主要包括與有效性相關的環評理論的分析、阻礙有效性的主要問題的討論、基於案例分析的有效性評估和爲了將環境政策有效納入流域管理而制定的理論框架及指標體系。該研究主要選擇了三組案例：中國七大流域第三輪流域綜合規劃修編的環境影響評價；福建省約1000個中小流域的流域綜合規劃的環境影響評價；流域水電規劃環境影響評價。這三組流域規劃的環境影響評價能夠很好地代表中國流域規劃環評的實踐，該研究根據在第二種制定的‘戰略環評的綜合有效性標準’對其進行了系統分析和討論，有效性的分析反過來又會進一步說明當前流域規劃環評中存在的問題。

基於上述分析，該研究的主要成果是適合中國流域管理和水資源管理制度的環境影響評價框架和指標體系，特別是累積影響評價的納入及其相關指標的建立，將會有助於在流域管理實踐中實現環境要素的有效納入。理論上，一方面，該研究是戰略環評首次在流域管理方面的系統分析；另一方面，它也是未來相關研究的基礎，並提出未來該領域的研究重點。

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Acronyms

ADB, Asian Development Bank

BOD, Biochemical Oxygen Demand

BOD_5, Five-Day Biochemical Oxygen Demand

CEA, Cumulative Effects Assessment

COD_{Mn}, Chemical Oxygen Demand; Oxygen Consumed

DO, Dissolved Oxygen

EA, Environmental Assessment

EC, Electrical Conductivity

EIA, Environmental impact assessment

EPD, Environmental Protection Department

EU, European Union

MEP, Ministry of Environmental Protection

MWR, Ministry of Water Resources

NDRC, National Development and Reform Commission

NH_3-N, Ammonia Nitrogen

PEIA, Plan-EIA, environmental impact assessment for plans

PRC, People's Republic of China

Project-EIA, environmental impact assessment for projects

SA, Sustainability Assessment

SD, Sustainable Development

SEA, Strategic Environmental Assessment

SHP, Small Hydropower Projects

TDS, Total Dissolved Solids

TP, Total Phosphorus

UK, United Kingdom

UNECE, United Nations Economic Commission for Europe

USA, United States of America

WFD, Watershed Framework Directive

Chapter 1 Introduction

This chapter attempts to introduce the research background, emphasizing the research significance and clarifying the research objectives. In addition, the structure of the dissertation is presented.

1.1 Backgrounds

Strategic Environmental Assessment (SEA) has been progressively developed as a promising tool for effective environmental management and enhancement of sustainable development since its early applications in decision-making processess at higher levels than the project level in the early 1980s (Quinn et al., 2002; Alshuwaikhat, 2005; Dala-Clayton & Sadler, 2005; Ren & Shang, 2005). Particular sectors, however, are short of SEA efforts and practices and only transport and land use plans are commonly considered as the only two ones with abundant SEA experience, although such SEA application has been receiving increasing concerns (Dala-Clayton & Sadler, 2005). Among them, the water sector has also adopted the SEA concept and taken the initiative to conduct SEA practices in development, adoption and implementation of watershed management plans, especially since the linkage between The SEA Directive and The Water Framework Directive (WFD). Besides, the UNECE Protocol on SEA (As referred to in Article 4 of The SEA Protocol, '*A strategic environmental assessment shall be carried out for plans and programs which are prepared for..., water management, ...*') and The 2003 EIA Law, PRC also respectively established the provisions of requiring SEA for watershed plans (EIA, environmental impact assessment). As the SEA practices in other sectors, the great majority of SEA efforts in water sector have been reported in developed countries and few in developing countries, albeit their recent emergence in those countries, such as China, Indonesia and India.

As known to all, the emerging water crisis in China is a hot potato, which not only potentially threatens China's prosperity and stability (Ramirez, 2005), but also could shake the world's grain market (Brown & Halweil, 1998) and even the global security. Water issues in China are characterized by serious water shortages, widespread water pollutions, worsening water environments and distorted aquatic ecosystems. According to Soltz (2005), 'eighty percent of China's rivers no longer support fish; most surface waters are polluted and many rivers no longer reach the ocean; the per-capita water availability in northwest China is only one-quarter of the world average and the second lowest on the planet'. In addition, a string of serious water pollution incidences occur, such as the blue-green algae outbreaks in the Tai Lake, the Chao Lake and the Dianchi Lake in 2007. Further, shrinkage of lakes, wetlands and estuaries, distortion in structures and functions of ecosystems and changes in water-dependent species are threatening increasing watersheds. Those have displayed the severity of China's water management crisis and implied the failure of previous efforts on managing water resources and watersheds.

In fact, early in 1988, Regulations on EIA of Water Conservancy and Hydropower Projects have been promulgated. After that, large amounts of associated Project-EIAs have been conducted both in the large-scale watersheds such as the Major Seven Watersheds and the small-scale ones in their respective administrative regions, especially EIAs of hydropower projects. Leaving aside their effectiveness, some insurmountable obstacles exist in project-EIAs themselves, which are to be expounded in Chapter 2. Failure to fully consider cumulative environmental implications is the most prominent one among them.

Both the ecological crisis, caused by the disorderly mini and micro hydropower developments in the West China, and the appalling water pollution incidents in recent years are such disastrous lessons, which press for effective and sustainable watershed management. For overcoming the inherent limitations of project-EIAs in water and watershed management, implementation of watershed-PEIAs (Plan-EIA, environmental impact assessment for plans, the prevailing SEA type in China and across the world) has been recognized as a turning point for addressing key water issues, reducing the biodiversity loss of water-dependent species and improving China watershed environments from the root. Accordingly, the government agencies have taken actions for implementing watershed-PEIAs.

Ministry of Environmental Protection (MEP), PRC has nailed down the regulation 'No approval of the hydropower project, if no associated watershed-PEIA' from 2007, as well as the issuance of The 2003 EIA Law, Ordinance of PEIA, and Regulation for EIA of Watershed Plans. International Workshop on SEA in China on December 3, 2007, aiming to further strengthen the unique role of watershed-PEIAs in China, also underlined that SEA for watershed plan during its planning process is one of the most urgent subjects. With those in mind, watershed-PEIA cases have welled up across the whole nation, including those for integrated watershed plans in Fujian, those for the nation-wide revision of integrated watershed plans, and numerous ones for watershed hydropower plans. Among them, the cases for the Jiulong River, the Yangtze River and the Muli River will be adopted for detailed analyses, which respectively represent the current dominating series of watershed-PEIAs: approximately 1000 cases of various scales in Fujian, the cases for the Major Seven watersheds, and the cases for hydropower plans. The technical procedures and methods in the case for the Jiulong River have been followed by most of the ones in Fujian. As for the case for integrated watershed plan of the Yangtze River, PEIA of Comprehensive Harnessing and Development Plan at the Estuary will be adopted for offsetting its limited documents and data. On one hand, the same agency is responsible for their PEIAs, following the similar techniques under the similar institutional arrangements; On the other hand, the case at the Estuary of the Yangtze River has been cited in *Comments on SEA Cases* of the EPD, PRC (EPD, 2009, 2^{nd}) as a good example. The case in the Muli River, which is listed in *Analyses on EIA Cases*, edited by the EIA center of EPD, PRC (2009), is the mirror of extensive and disorderly hydropower developments in southwest China.

Increasing watershed-PEIA cases in EU states, in America and in Asia indicate growing concerns on them across the world. However, the efforts for watershed-PEIAs are still at the initial stage, whether at home or abroad, and their effectiveness is baffled, due to insufficient relative researches, lack of advanced methods and techniques, unsound institutions and legislations and otherwise.

Although numerous articles about SEA and watershed management theories are available in the journals across the world, few specific publications concerning watershed-PEIAs are found (Grayson & Doolan, 1995; Heathcote, 1998; Hedo & Bina, 1999; Carter & Howe, 2006; Heathcote, 2009). Even today, when, with the linkage of The SEA Directive and WFD, more and more nations have applied SEA to their watershed planning processes, there is no evidence that associated researches have received increasing attention. Obviously, the associated researches lag behind such practices.

Furthermore, although such experiences from EU WFD could be used for reference, they should never be copied without major amendments, owning to different political, economical systems and cultural backgrounds. Therefore, the current study attempts to introduce the necessity of watershed-PEIAs, to analyze the evolution of watershed-PEIAs across the world, to identify the status of China's watershed-PEIA practices and explore the main obstacles ahead of watershed management and associated PEIA practices, to improve the watershed-PEIA system by avoiding the main obstacles if possible, and to design a practical and context-specific watershed-PEIA framework with the indicator system.

This framework is to be built from technical and institutional perspectives. The improvement of the institutions will be achieved by political dialogues, based on the joint efforts of the experts, the academics, the government, the media and the public. Here some ideas for improving the contexts will be presented, but no attempt will be made to achieve the necessary improvements in the decision-making system instantly. Moreover, CEA, with associated cumulative environmental indicators, will act as an integral part of the watershed-PEIA framework, rather than a dispensable appendage. In other words, theoretically, effective watershed-PEIAs should be watershed-based CEAs, focusing on cumulative implications in watershed developments. Therefore, the core of the technical aspect in the watershed-PEIA system is the CEA framework, together with its indicator system.

1.2 Significance

As mentioned above, few articles are available with focus on watershed-PEIA as references, indicating the shortage of associated researches. In this sense, this study can be taken as an initial step into future researches and can help to step further into this field. Recent studies on watershed-PEIAs mainly focus on brief introduction of the cases and seldom touch the theoretical ground. In addition, researchers seem to pay more attention to PEIAs for watershed hydropower plans, rather than those for integrated watershed plans. However, the cumulative implications of integrated plans are more severe and more uncertain than its involved specific ones; and PEIAs for integrated watershed plans are more significant, which will be discussed in Chapter 2. In this study, more concerns will be given on integrated watershed plans.

Moreover, context-specific framework is also highlighted in this research. Although watershed-PEIAs in EU, America and other regions are possible for providing references for us to improve the similar efforts in China, they should never be copied without considering the differences in political, institutional, legal and cultural backgrounds, as well as those in capacity building. It is advisable to build a framework specific to China, which is another attempt in the study.

Practically, the research results of this study aim to provide guidelines for effective linkage between PEIA and watershed management and for systematically assessing cumulative consequences of watershed developments. Traditionally, CEA, if appropriate, often works as a separate process from PEIA, rather than an integral part of it. In this study, CEA will be put in the watershed-PEIA process, as a necessary and pivotal part of the whole PEIA process.

1.3 Research Objectives

As Heathcote (2009) noted, watershed management is not just a technical challenge; it is also a social challenge. Similarly, it is both the technical contexts and the political contexts that are baffling the effective implementation of watershed-PEIAs. Although political and institutional contexts, under which water resources and water environments are managed, are critical for the effectiveness of watershed-PEIAs and will be theoretically analyzed in brief, they are not the key topics of this study. Due to the fact that the issue about contexts is not an easy one, to clearly and easily address it is beyond the scope of this current study, especially in China, which is 'an illustrative-and-extreme-case of the difficulties of balancing the pursuit of economic, social, and environmental objectives' (Bina, 2008). However, beneficial ideas for improving the institutional, legislative and cultural contexts are also advisable for achieving an enabling management system in the study. Moreover, fortunately, it should be noted that political backgrounds and institutional contexts for SEA and watershed management, indeed, have been and will still be in continuous improvement, although they are still in a very bad situation and the improvement speeds are extremely slow. Undeniably, both the avocation of PEIA and the development of integrated watershed management have, in turn, played, or will play, some roles in improving the governance structure and decision-making skills. Therefore, the procedures, methodologies, and indicators specific to watershed-PEIAs and China's water management institutions desiderate to be further studied and optimized, which are really worthy of concern, together with the stepwise improvement of the institutions, rather than which will be thought over after a sound and perfect political system takes shape (a pie in the sky). Adoption of appropriate methods and procedures could improve the PEIA effectiveness by influencing its process and results, if no changes can be made in associated institutional contexts.

With this regard, the core objective of this research is to develop a rational framework and a practical indicator system for integrating SEA into watershed management and maximizing the effectiveness of such SEA practices, if possible, in China. Currently, to improve the technical dimension is of more significance than the institutional one, although it is essential to continuously improve the decision-making and institutional contexts. Generally, the improvement of the institutions will be achieved by political dialogues with the collective efforts of the experts, the academics, the government, the media and the public. However it will take a considerably long period of time.

As for the indicators involved in watershed-PEIAs, especially those associated with cumulative effects, they will be carefully analyzed as a crucial part of the technical dimension for analyzing and assessing environmental potentials. On one hand, indicators for CEA will be included for key consideration. On the other hand, these indicators will involve all the main comprehensive and high-level environmental implications of integrated watershed plans and associated specific ones (totally 13 specific plans in an integrated watershed plan based on the technical requirements of Nation-wide Revision of Integrated Watershed Plans initiated in year 2007), which is a general one capable of providing references for various watershed plans. Thus the produced reports are easily adopted for comparison.

As mentioned in Section 1.1, CEA will be elaborated as an integral part of watershed-PEIA. Therefore, in this study, sources of cumulative environmental consequences, main cumulative environmental potentials induced by watershed developments, and common CEA methods, especially those appropriate for watershed-PEIAs due to the 'large-scale' nature of most watersheds in China, will be particularly discussed. These study results about CEA of watershed developments should be beneficial to future associated researches and practices, because it is often recognized as a necessity but a difficulty in PEIAs, especially those PEIAs in large-scale integrated watershed developments.

Moreover, 'context-specific' is of particular note in this study, and some ideas and methods for watershed-PEIAs will also be presented, being specific to China's watershed management institutions. This viewpoint is also advisable for PEIAs in other sectors. Although the PEIA methods and ideas in other nations are useful references, different political and institutional backgrounds indicate the differences in their PEIA systems and the involved agencies. Therefore, context-specific PEIA systems in various sectors of each nation are preferred.

For creating such a theoretical framework and a corresponding indicator system, the status quo of such practices need to be investigated, especially the current limitations and challenges. It is the subsidiary objective and also the precondition for further research.

To achieve the above objectives, the following three questions have to be answered: 1) Is it necessary to integrate SEA into watershed management? - necessity; 2) Are/have the technical contexts or the political backgrounds or both baffling/baffled the effectiveness of watershed-PEIAs in China? - implementation and the main challenges; 3) How can PEIA be effectively integrated into watershed management?- the framework and indicator system. The first question will be addressed in Chapter 2. Chapter 4 and Chapter 5 focus on identifying the status of current watershed-PEIA arrangements and practices, especially the main challenges and obstacles of conducting and implementing watershed-PEIAs. For addressing the third question, the context-specific new framework will be developed in Chapter 6 based on the analyses in Chapters 4 and 5.

1.4 Structure of the Dissertation

This dissertation is divided into seven chapters (Fig. 1.1). Chapter One introduces the research backgrounds, significance, and objectives. The literature review will be presented in Chapter Two, aiming to elaborate on the international perspectives about watershed-SEAs. In Chapter two, the main contents include the key SEA topics, watershed management theories, and environmental implications of watershed developments, necessity and rationality of SEA for watershed management and the efforts for watershed-PEIAs across the world. The study roadmap and the main methods are presented in Chapter Three. Chapter Four focuses on analyzing the non-technical arrangements of watershed-PEIAs, legal and institutional ones, for helping understand the investigation results in Chapter Five. Then, based on data and information from documentary study, investigation and case study, the main watershed-PEIA cases, their performance and the main challenges in the watershed-SEA system of China will be identified in Chapter Five. In addition, the effectiveness of several cases will be estimated in Chapter Five. Further, suggestions and ideas for further improvement of the watershed-SEA system will be also presented. In Chapter Six, a general, practical and context-specific watershed-SEA framework, mainly including the improvements in institutions, technical dimension and the indicator system, especially those associated with CEA, will be built up according to the analyzing results and suggestions for improvement. Finally, the main findings in this study and the concerned research directions are presented and discussed in Chapter Seven.

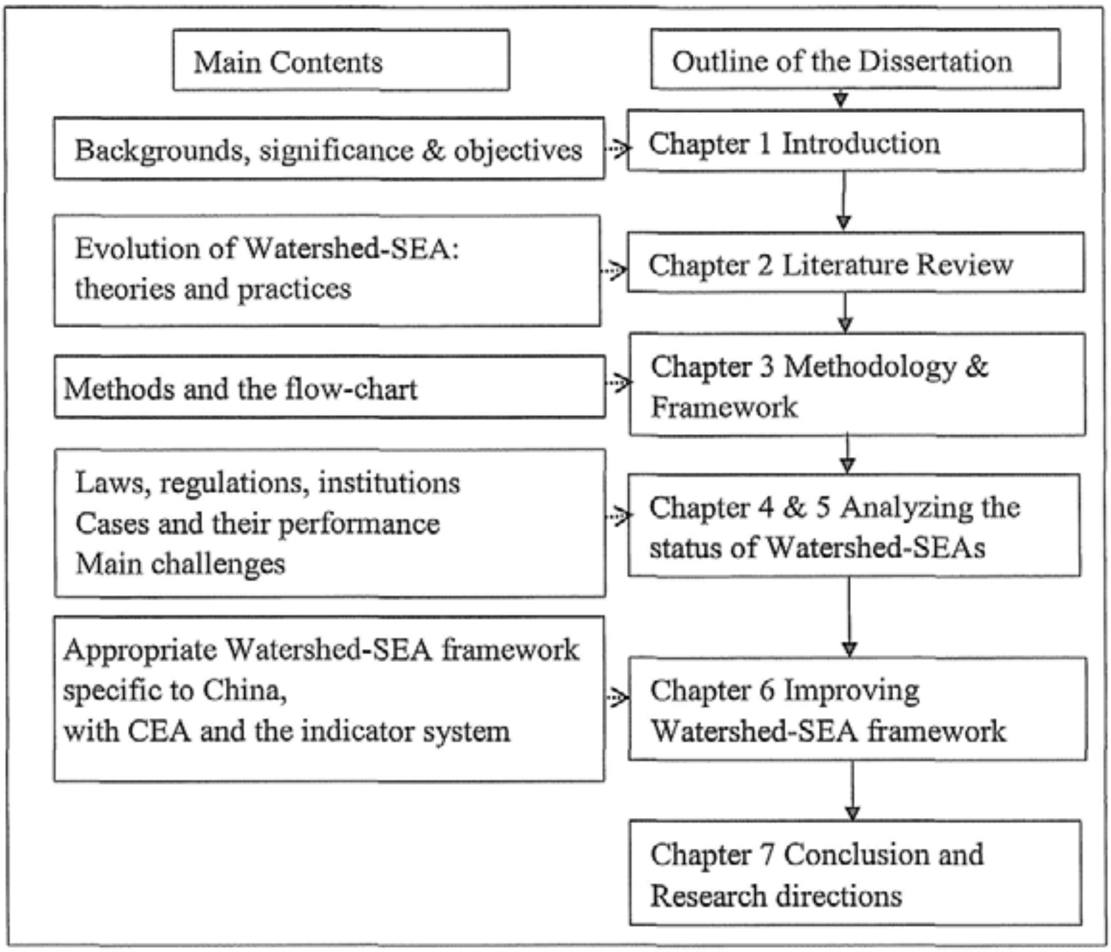

Fig. 1.1 Structure of the Dissertation

Chapter 2 Literature Review

This chapter introduces and presents the evolution of theories and practices associated with watershed-PEIAs (Plan-EIA, environmental impact assessment for plans) from the international perspective. They are mainly related to several key SEA (strategic environmental assessment) themes, watershed management theories, environmental implications in watershed developments, and the necessity of linking watershed management with SEA.

2.1 Evolution of SEA Theories

SEA for policies, plans and programs has evolved rapidly and received growing attention internationally, since the first application of the term 'SEA' reportedly in a draft report to the Commission in European Community in 1989 (Fischer, 2002; Dalal-Clayton and Sadler, 2005). Its evolution has strong relationship with the inherent limitations of Project-EIA (environmental impact assessment for projects). Firstly, therefore, the definitions of EIA (environmental impact assessment) and SEA, the limitations of Project-EIA and the need for SEA will be introduced in the following sub-sections, for easily understanding of the research.

So far, there have been several reviews about SEA researches and practices. However, the expanded and expanding theatre of SEA practices has brought changing perspectives to this field (Sadler, 1996). Here, the research progress on SEA at home and abroad will be illustrated, based on some of the joint key SEA thematic areas for all countries and all sectors, such as effectiveness, CEA, public participation, SEA contexts and uncertainties. Lacking advanced methods for CEA, limited public participation, political backgrounds and institutional contexts, and great uncertainties of watershed plans, especially uncertainties of integrated watershed plans, often greatly influence the effectiveness of watershed-PEIAs. That's why they will be elaborated in Section 2.1. The ideas obtained from their analyses could be used for assessing and explaining the current watershed-PEIA status, and helping to develop the improved framework from institutional and technical arrangements.

2.1.1 Introduction of EIA and SEA

(1) Definitions

EIA, environmental impact assessment, was introduced in the *US National Environmental Policy Act* (NEPA) in 1969 (Fischer, 2002), which is the process of identifying, analyzing, predicting and evaluating environmental implications of an action proposal, aiming for a environment-friendly decision. Heretofore, it has been adopted in more than 100 countries or regions, with experience of almost 40 years (Sadler, 1996; Yu, et al. 2004). EIA is a broad concept, which deals with the environmental considerations in decision-making processes of policies, plans and programs (PPPs), as well as those of individual projects. However, early EIA efforts focused on the Project-EIA, seldom considering the environmental integration into PPPs at higher levels, although a small quantity of SEA-type approaches had been applied by some European and American countries in late 1970s and 1980s (Luo & Zhou, 2000; Dalal-Clayton & Sadler, 2005).

For SEA, there has been large variety of definitions, related terminology and acronyms, proposed by practitioners, academics and authorities (Dalal-Clayton & Sadler, 2005). Although early definitions are often seen as an extension to EIA, SEA has been commonly applied as a systematic process of analyzing the environmental effects of polices, plans, and programs (PPPs) and is increasingly accepted as an entry point for sustainability appraisal by including social and economic considerations (Therviel et al., 1992; Dalal-Clayton & Sadler, 2005).

As mentioned in many literatures, the overwhelming objective of SEA is to achieve sustainable development (SD). Sustainable development is generally recognized to comprise three dimensions: economic, social and environmental potentials when deciding development proposals. As Carter et al. (2009) noted, both SEA and SA (sustainability assessment) are essentially strategic appraisal procedures used to highlight potential impacts related to the implementation of PPPs. Their key difference is that SA covers a wider remit of effects, including social and economic considerations, as well as the key focus of SEA: environmental impacts (Carter et al., 2009; Hanusch et al., 2008). Now that SA may become the dominant strategic tool superseding SEA (Carter et al., 2003), why we still apply SEA, rather than SA (sustainability appraisal) for achieving sustainable decisions, in most cases? The core reason is that lack of or undervaluing environmental considerations is the main obstacle of SD nowadays, and will remain so in a long period of the future, because the trends towards socio-economic benefits are most favored by tradition, especially in developing countries (Bi & Gao, 1994). With regard to this, it is practical that SEA acts as a transitional tool of SA before the overriding environmental constrains can be effectively controlled. SEA does not intend to aggrandize environmental implications, but make great efforts to integrate all of three dimensions into decision-making process under the current economic climate with the worldwide emphasis on economic well-being rather than total quality of life (Therviel et al., 1992). Social and economic priorities are by tradition most important.

(2) Limitations of Project-EIA and Benefits of SEA

Bina (2007) explored the links and overlaps between the concepts and approaches of SEA and those of EIA, who argued that 'this was not a case of evolution from EIA to SEA, but rather the application of EIA and essentially of its approaches, to progressively higher levels of decision making'. SEA is the extension of EIA from the project level to more strategic levels, and is part of EIA (Therviel et al., 1992). It is dangerous for comparing SEA with EIA. For avoiding the confusion caused by such overlaps, 'Project-EIA' is applied in the following sections of the dissertation for clarity (Therviel et al., 1992).

As mentioned above, SEA is not only viewed as an improvement on the Project-EIA process in most cases, but also has been generally seen as a step stone for sustainability. With the development and popularity of SEA, the following limitations of Project-EIA have been identified:

1) It is unable to conduct environmental assessment (EA) of important decisions, with potential environmental implications, at their early stages during the formulation of PPPs (Bina, 2007);
2) 'It cannot steer development proposals towards environmentally resilient locations or away from sensitive areas' by reacting to development proposals rather than anticipating them (Therviel et al., 1992);
3) It fails to consider adequately the cumulative environmental impacts of all the projects in one region such as one watershed;
4) 'It only addresses alternatives to the proposed project in a limited manner', because 'the details of the project are already drawn up' before the project-EIA (Therviel et al., 1992), or even it never takes account of alternatives and only aims to obtain the project approval.

These limitations, together with limited mitigation measures and timescale and so on, require SEA as an improvement over Project-EIA (Therviel et al., 1992). Then, what benefits can be obtained by introduction of SEA into decision making? The following sub-section intends to answer it.

SEA is a systematic and an iterative process, which hammers at the integration of environmental implications into the whole decision-making process (policy, plan and program), on par with economic and social objectives. The integrations of environmental considerations into decision making, together with economic and social considerations, can promote the establishment of sustainable decisions (Therviel et al., 1992; Sadler, 1996; Fischer, 2002; Ren, 2005). Secondly, its early integration into decision-making process allows of large amounts of alternatives, including 'no-action' alternative, in order to obtain the environment-friendly decision (Fischer, 2002). Thirdly, it can consider the cumulative environmental impacts of all possible projects in one region (Fischer, 2002; Dalal-Clayton & Sadler, 2005). Cumulative effects Assessment (CEA) is especially crucial for those small-scale projects, whose cumulative negative environmental implications may cause ecological disasters, despite the trifling environmental impacts of an individual project. Fourthly, effective implementation of SEA can exclude some environment-unfriendly development proposals at higher decision levels, and accordingly avoid the unnecessary Project- EIAs, so as to streamline EIA processes (Fischer, 2002; Dalal-Clayton & Sadler, 2005).

Limitations of Project-EIAs and benefits of SEAs combine to indicate the need and the rationale for SEA. As Dalal-Clayton & Sadler (2005) stated, 'the rational for the SEA of PPPs falls into three main categories: strengthening Project-EIA; addressing cumulative, large-scale effects and advancing the sustainability agenda'. Therefore, SEA would not only overcome the worst limitations of the Project-EIA system, but would also be a proactive step towards sustainability (Therviel et al., 1992; Hanusch et al., 2008; Desmond, 2009). However, especially to deserve to be mentioned, the popularity of SEA doesn't imply that SEA should override or supersede project-EIA. The effective linkage of them should be the desirable way. SEAs would set a framework, within which specific project-EIAs, especially for those with environment-unfriendly potentials, should be carried out, rather than be eliminated.

2.1.2 SEA effectiveness

As Sadler (1996) mentioned, 'a concern with effectiveness is an overarching and integral theme of EA theory and practice'. In 1993, an international study on the effectiveness of environmental assessment was conducted, at the Shanghai meeting of the International Association for Impact Assessment (IAIA), which highlighted several aspects to be improved (Sadler, 1996). In recent years, 'evaluating SEA systems and performance has obtained considerable attention in the international academic literature' and various sets of SEA performance criteria have been developed and different methods for evaluating SEA performance have been introduced, with increasing concerns on the effectiveness of SEA (Sadler, 1996;

IAIA, 2002; HK, 2004; Baker, 2003; Fischer, 2006; Noble, 2009).

Three dimensions of EA effectiveness, including SEA effectiveness, have been involved for evaluating the EA systems and performances: substantive, procedural and trans-active (Saddler, 1996; Fischer, 2002; Baker, 2003). Substantive effectiveness relates to the fundamental contribution of the SEA performance to better decisions and the realization of the established environmental objectives; procedural effectiveness relates to the extent to which SEA procedures and provisions are involved; the trans-active dimension means to determine the extent to which the SEA process and procedures deliver the substantive dimension *at least cost in the minimum time possible* (Fischer, 2002; Sadler, 1996; Baker et al., 2003).

Correspondingly, three main kinds of systematic approaches for evaluating the above overall SEA performance and effectiveness have been developed: prescriptive approach, policy and program evaluation methodologies, and 'a life-cycle approach', despite still no standardized methods and tools (Sadler, 1996). The first one is used for comparing what should be done with what is done, which is widely followed (e.g., Chapter 5). The second one is widely applied in government for examining the larger context of decision making (e.g. Chapter 4). The third one is an evaluation cycle including the three interconnected stages from pre-to-post decision-making, as depicted in the 'Effectiveness triangle' of Fig. 2.1, which focuses on the trans-active relationship among policies, practices and performances and can be applied for measuring the overall SEA effectiveness (Sadler, 1996).

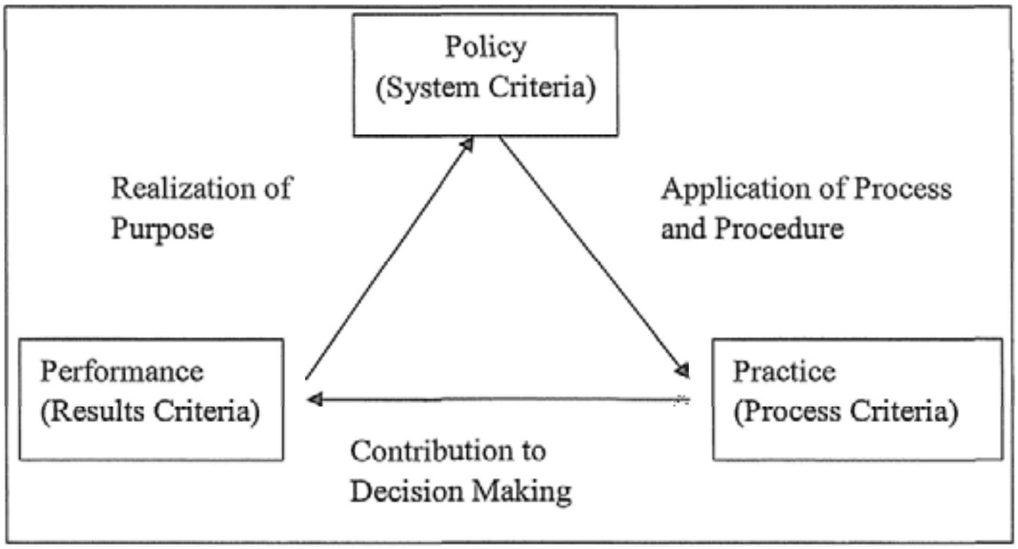

Fig 2.1 Effectiveness Triangle with Criteria

(Modified from Sadler (1996) and Nobel, 2009)

Based on the IAIA (2002) performance criteria, Noble (2009) grouped them into system, process and results criteria, used to evaluate the SEA practices in Canada. Therefore, the SEA effectives could be broken down along three lines: system effectiveness, process effectiveness and results effectiveness. Of particular concerns, 'no universal set of criteria can equally apply to all SEA contexts' and evaluation should be applied specific to political and institutional contexts, because 'SEA operates in diverse forms, under a range of institutional and methodological frameworks and expectations' (Sadler, 1996; Noble, 2009); as such, no universal set of criteria can equally apply to all areas and all sectors.

Sadler's 'Effectiveness triangle', including substantial (performance), procedural (process) and tans-active (efficiency) aspects, has been accepted and improved as a basic template for evaluating the EIA effectiveness of different levels: system-wide reviews of EA experience, activity, and outcomes; decision audits of the application of the EA process from start to finish; component-specific evaluations of particular stages or components of the EA process (Sadler, 1996; Baker, 2003). Baker (2003) added a normal aspect (Purpose) to the 'Effectiveness triangle', for defining the extent to which the proposed decision achieves the normative goals, such as sustainable development. In this manner, a circular effectiveness cycle, as shown in

Fig. 2.2, was developed for evaluating the overall effectiveness of proposed decisions integrated by SEA instruments, by linking the above four aspects to proposed decisions and by their respective effectiveness measurements (Baker, 2003).

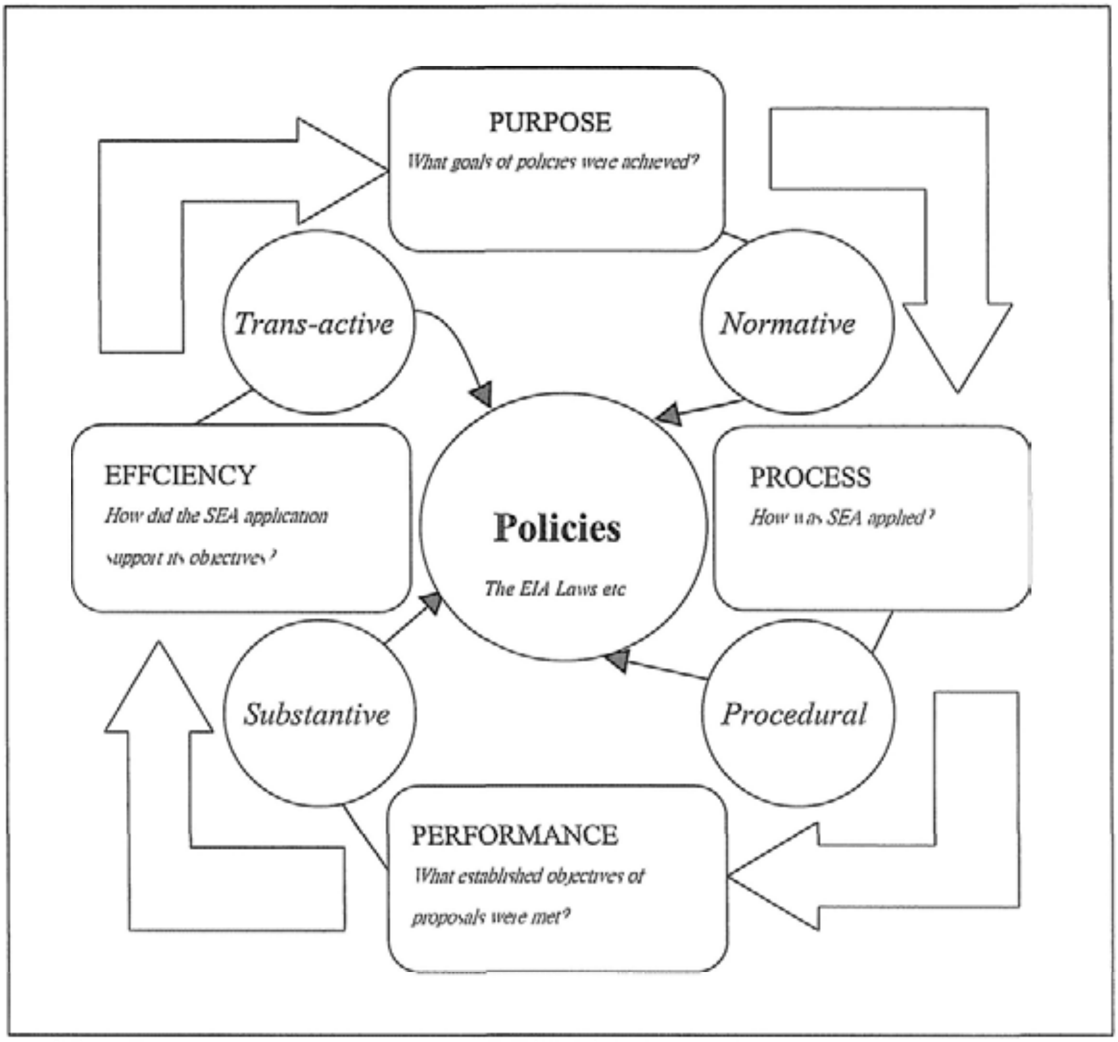

Fig. 2.2 A Circular Effectiveness Cycle for the EIA Laws

(Modified from Baker, 2003)

Despite so many efforts for developing effectiveness criteria and the effectiveness-evaluating approaches, disregard of decision-making backgrounds and contexts is fatal. The core reasons of blocking the effective SEA implementation are, in most cases, the issues relating to political cultures and institutional backgrounds, such as lack of powerful environmental governance and accountability, other than the technical issues (Sadler, 1996; Sadler, 2005; Fischer, 2002; Fischer, 2006; Bina, 2008; Nobel, 2009; Nykvist et al., 2009). Therefore, 'incremental effectiveness' has been presented, evaluating the incremental influences of the SEA efforts on environmental awareness, sustainable mindsets, political cultures and institutional improvements, besides the above four dimensions of 'direct effectiveness' (Bina, 2008).

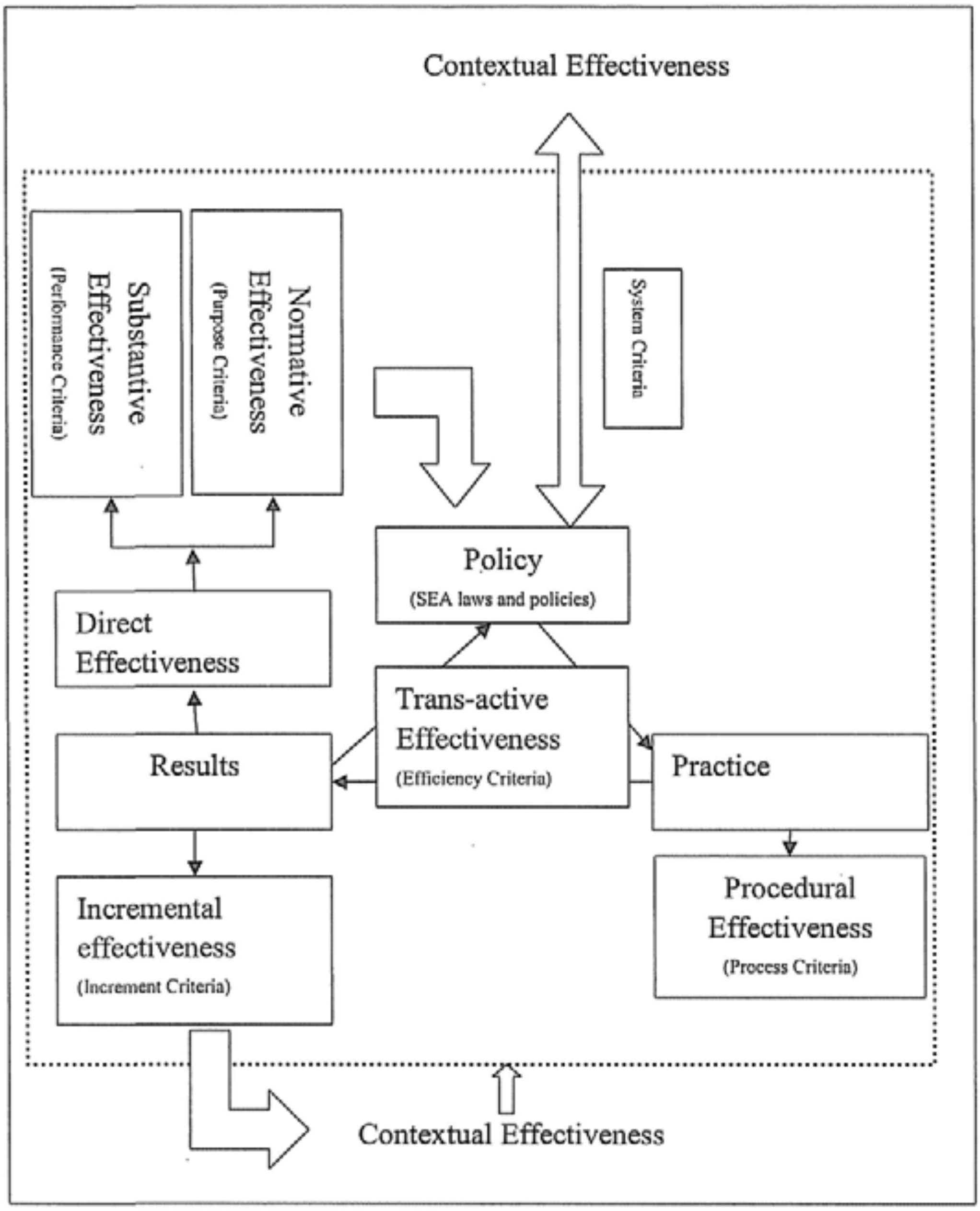

Fig. 2.3 The Overall SEA Effectiveness

(After Baker, 2003 with modifications and improvements based on Bina, 2008)

Thus, to sum up the previous efforts for evaluating overall SEA effectiveness, a revised and improved 'overall effectiveness framework' is proposed, which combines the views of Sadler (1996), Baker (2003) and Bina (2008). Both the normative effectiveness and the incremental effectiveness are in the system-process-result framework from Sadler's 'effectiveness triangle'. In addition, the political, institutional and cultural contexts should also be evaluated as the determinant dimension of the overall SEA effectiveness, named as contextual effectiveness. The 'overall effectiveness framework' is shown in Fig. 2.3 and its details are to be explained in the subsequent subsections.

The components of the circular effectiveness cycle and their respective criteria are revised and improved, based on Baker's circular effectiveness. Here, the overall SEA effectiveness is categorized into six aspects: procedural effectiveness, substantive effectiveness, trans-active effectiveness, normative effectiveness, incremental effectiveness and the crucial contextual effectiveness. Among them, incremental effectiveness is used for evaluating the indirect impacts from SEA process.

(1) Procedural Effectiveness (Process criteria)

The procedures and methodologies adopted through the whole SEA process and the decision-making process are key factors for determining the technical quality of the documents produced by the SEA actors and decision-makers (Sadler, 1996). Examination of procedural effectiveness is to find out the extent to which the SEA application process meets the requirements of accepted principles and procedures (Baker, 2003). A multitude of criteria, associated with the procedures and methodologies, can be applied for this dimension of effectiveness, such as available data sources; timeliness of integrating SEA instruments into the decision-making process; technical soundness of screening, scoping and impact assessment/predictions; consideration and evaluation of alternatives; involvement of CEA; the opportunities for public involvement, access to information; tradeoffs between different interests and use of appropriate consultation techniques; involved agencies at any stage of SEA. However, in broad perspective, four components of process effectiveness are of particular concerns: alternatives; cumulative effects; follow-up and monitoring program; and public participation.

(2) Substantive Effectiveness (Performance criteria)

Substantive effectiveness is the core of the overall SEA effectiveness, which determines the extent of achieving SEA objectives for proposed decisions. Its core component is the success or shortfall of SEA performances. For evaluating it, two categories of criteria, respectively specific to immediate and secondary aims should be involved. The criteria relating to immediate aims include the following: a full range of considerations of social, ecological and healthy consequences for environmental protection and sustainable development; precise and verifiable predictions; appropriate and successful mitigation measures; clear and understandable information and documents available for the decision-makers. The secondary aims are to provide opportunities for system-wide leaning and system improvement, and the criteria for examining indirect results, which could also be recognized as '*incremental effectiveness*', including the improvement of coordination among different sectors, agencies and groups of interests; community development and capacity building; promotion of environmental awareness; instillation and impulse of environmental accountability (Sadler, 1996; Bina, 2008; Noble, 2009).

(3) Trans-active Effectiveness (Efficiency/cost criteria)

Cost- and time-effective application and implementation of SEA process and its outputs are desirable, which is the central dimension of trans-active effectiveness. For evaluating trans-active effectiveness, the time- and cost-benefit analyses of integrating the SEA process and outputs into the decision-making progress should be undertaken. Moreover, the time and the cost for taking mitigating measures and improving policies and laws are also important aspects of this kind of effectiveness. As Baker (2003) noted, 'Trans-active effectiveness is the extent to which the least cost was incurred and the minimal amount of time used in achieving objectives'. The promotion of trans-active effectiveness counts on the enabling political cultures, the proficient SEA actors, appropriate procedures and active participation of stakeholders.

(4) Normative Effectiveness, relating to the goals of the EIA polices (Purpose criteria)

The normative effectiveness lies at the heart of the difference between 'Effectiveness triangle' and 'Circular Effectiveness Cycle'. It means the extent to which the normative purposes of the current SEA laws and regulations are achieved (Baker, 2003). The normative purposes are deduced from the researches and practices, according to international SEA perspectives. The current EIA laws, polices and regulations should be incrementally improved for achieving the normative purposes based on the evaluation results of normative effectiveness. For example, more and more SEA researches tend to regard sustainable development as the normative purposes of SEA polices, balancing the tradeoffs amongst economical, social, environmental and healthy considerations.

(5) Incremental Effectiveness (increment criteria)

According to Bina (2008), most of the above four aspects of effectiveness can be categorized into the 'direct effectiveness'. The components specific to secondary aims of evaluating 'substantive effectiveness' will be used for 'incremental effectiveness' in this research. It could be analyzed as part of 'substantial effectiveness' and as a separate one from 'substantial effectiveness'. Incremental effectiveness means the incremental improvement of the capacity for more sustainable decisions, under the impacts of the SEA practices and researches on the contexts. The contents of incremental effectiveness include the changes in decision-making mindsets, environmental awareness, the participatory cultures, and the institutional arrangements (Bina, 2008).

(6) Contextual effectiveness referring to Political, institutional and cultural contexts (system criteria)

The political, institutional, legal and cultural contexts underpin any national or regional SEA system, which are overarching determinants of effectiveness. A central dimension of system effectiveness is whether enabling conditions and contexts of sound performance exist. In other words, effective and supportive cultures for SEA systems help to deliver the procedural and substantive dimensions of SEA effectiveness time- and cost- efficiently, so that the trans-active effectiveness is guaranteed. EA laws and policies, together with enforceable terms and conditions, clear procedural and methodological provisions, technical guidelines, political commitment, legal framework, institutional support and the educational levels combine to form the unique national SEA system, which are the integral parts of system effectiveness. Usually, the comparative evaluations of the SEA systems under different institutional regimes can be adopted for identifying their relative strengths and constraints with respect to the enabling conditions (Sadler, 1996).

The overall SEA effectiveness consists of a large set of elements and indices, which serves an evaluation framework. Selection of components and indices will depend on the evaluation concern, the analysis purpose and the data availability. For example, in order to examine the status of SEA for watershed planning in China, only a small part of elements and indices will be selected for this study due to the data availability and the restricted research support from the relevant authorities and individual person.

2.1.3 Cumulative Effects Assessment

Interests in the assessment of cumulative environmental changes caused by projects and other human activities have grown since the late 1970s (Kamath, 1993; Canter, 1995; Smitt, 1995; Rees, 1995). CEA has been accepted as an integral part of EIA processes, which provides valuable and necessary inputs as an element of SEA

(Therivel, 2007). Better consideration of CEA in SEA than in Project-EIA is also the main benefit (Therivel, 2007). It has been required as part of EIA (including SEA) process in many countries, such as the USA, Canada, the UK, and Sweden (Canter, 1995; Smit, 1995; Therivel, 2007; Wärnbäck, 2009).

However, most CEA efforts have been focused on project-EIA rather than SEA (CEAA, 2004;Therivel, 2007) and the cursory involvement or even no consideration of cumulative effects in SEA processes has been a regular problem (Sadler, 1995; King, 2008; Wärnbäck, 2009), which limits the procedural, substantive and normative SEA effectiveness (Rees, 1995). In most cases, the reasons for marginal consideration of CEA in SEA systems include its technical complexity, the uncertainty of the assessment outputs, non-proficient SEA actors, limited initiatives from institutions and authorities, lack of legislative requirements, weak accountability, lack of data, information and guidance, time-consuming and cost-consuming problems. For example, the 905 SEA cases for integrated watershed planning processes in Fujian, China, any of their watershed areas being less than 500 km^2, were completed by 30 EIA agencies in only three months. In the limited time frame, it is knotty to accomplish the following '*batch*' of workload, such as to consider all projects with environmental potentials involved in a comprehensive watershed plan, to collect and process the necessary baseline data, to select a set of appropriate methodologies for evaluating the cumulative environmental changes of current and future water-dependent projects in watershed plans, to identify the temporal and spatial boundaries, and to allow of effective public participation.

(1) Introduction of cumulative effects

Definitions of cumulative effects are diversiform, any of which varies in the coverage and focuses of impacts. However, all of them imply the major idea: the impacts on environments over time across space, such as a watershed, due to time-crowding and spatial-crowding of vast small perturbations, including the past, current and probable future ones, or the ancillary activities to large-scale projects

(Canter, 1995; Spalling, 1995; Rees, 1995; Quinn, 2002; Cooper, 2002). Of particular concern, cumulative effects can involve individually insignificant but collectively significant ones over time and space. In addition, some substitutes of cumulative effects were applied, such as in-combination effects, combined effects, collective effects or effects interactions. Different methods were developed for classifying cumulative effects.

Three main components are generally as the criteria for classifying cumulative effects: source, process and effects (Smit, 1995; Quinn, 2002). Based on the three criteria, the categories of cumulative effects are depicted in Fig. 2.4. Either single action or multiple actions may contribute to cumulative environmental effects. Single action brings cumulative effects by repetitive disturbances into the environmental system, such as the continuous discharge of a drainage system (Spaling, 1995). As for multiple-action cumulative effects, Irving (1986) classified it into homotypic effect, caused by multiple sources of the same type, and heterotypic effect, induced by two or more sources of different types (Canter, 1995). In addition, three basic pathways or processes of accumulating environmental changes, additive, synergistic and antagonistic, were identified: the first one occurs when no interactions among all projects or activities involved in a proposal; the second and third ones combine to belong to the interactive and non-additive effects (Canter, 1995), which are distinguished by biomagnifications, synergistic or countervailing manner. Finally, cumulative effects behave as temporal accumulation over time or spatial accumulation over space (Quinn, 2002), therefore, the cumulative effects can also be categorized into time-crowding and space-crowing ones (Smitt, 1995; Spaling, 1995). Time-crowding one means that the continuous inputs into an environmental system occur so that the time interval between each input is less than that required for the system to assimilate the disturbance or to be recovered (Rees, 1995). Space-crowding one is the spatial accumulation of too over-laden disturbances due to the excessively near spatial proximity between them, even they are small-scale individuals. As for other criteria for categorizing cumulative impacts, they will not be included in this study.

(2) Project-EIA CEA and SEA-linked CEA

CEA is different from EIA at all levels, because the former focuses on the given receptors, such as climate change, biodiversity and water quality, receiving all the likely effects of past, current and future activities, but the latter emphasizes the environmental consequences of a particular activity or proposal in question, including polices, plans, programs and projects. CEA should not be separated from project-EIA or SEA process, which should focus on all of the likely effects on given receptors in the receiving environment (Scottish Executive, 2003; Therrivel, 2007). However, past CEA procedures focused on the theoretical research, CEA being as a separate add-on of EIA or as the 'last hurrah' and an extension of EIA for development proposals. CEA is seldom addressed in great details in EIAs, especially in SEAs, and even a great part of EIA documents didn't mention the term 'cumulative effects', despite the legal stipulation of CEA in many national or international SEA systems, such as Canada, England and Sweden (Sadler, 1995; Cooper, 2002; Therrivel, 2007; Wärnbäck, 2009). How to deal with cumulative effects in practice and incorporate the CEA procedures into the EIA system are often ignored, both at project-and strategic level, because CEAs have never received the deserved attention in EIA process (Sadler, 1995; Canter, 1995; Cooper, 2002; Wärnbäck, 2009).

The last three decades have witnessed the two dichotomous evolving tracks of CEA theories and practices: Project-based CEA and Regional-based CEA (Quinn, 2002; Dubé, 2003). As Dubé (2003) noted, Project-based CEA works as an extension of the EIA process for project development, focusing on local, project-related stressors and stressor-based (S-B) methods; Regional-based CEA exists as a broader, regional environmental assessment and management tool, which could be integrated into the EIA process, but should not be constrained by the EIA process. Regional CEA approaches are developed mainly outside the EIA process (Dubé, 2003), possibly due to the recent CEA requirements or even no CEA requirements in SEA legislations and guidance, although the linkage of CEA and SEA and the relevant methods have received increasing concerns. Regional CEA emphasized the effect-based (E-B) methods to evaluate the environmental response to multiple stressors (Reid, 2001; Quinn, 2002; Dubé, 2003). E-B methods or 'after-the-fact' methods limit the predicting capacity of CEA, because the effects are often applied for retrospectively identifying what and why happened, after the effects have been detected.

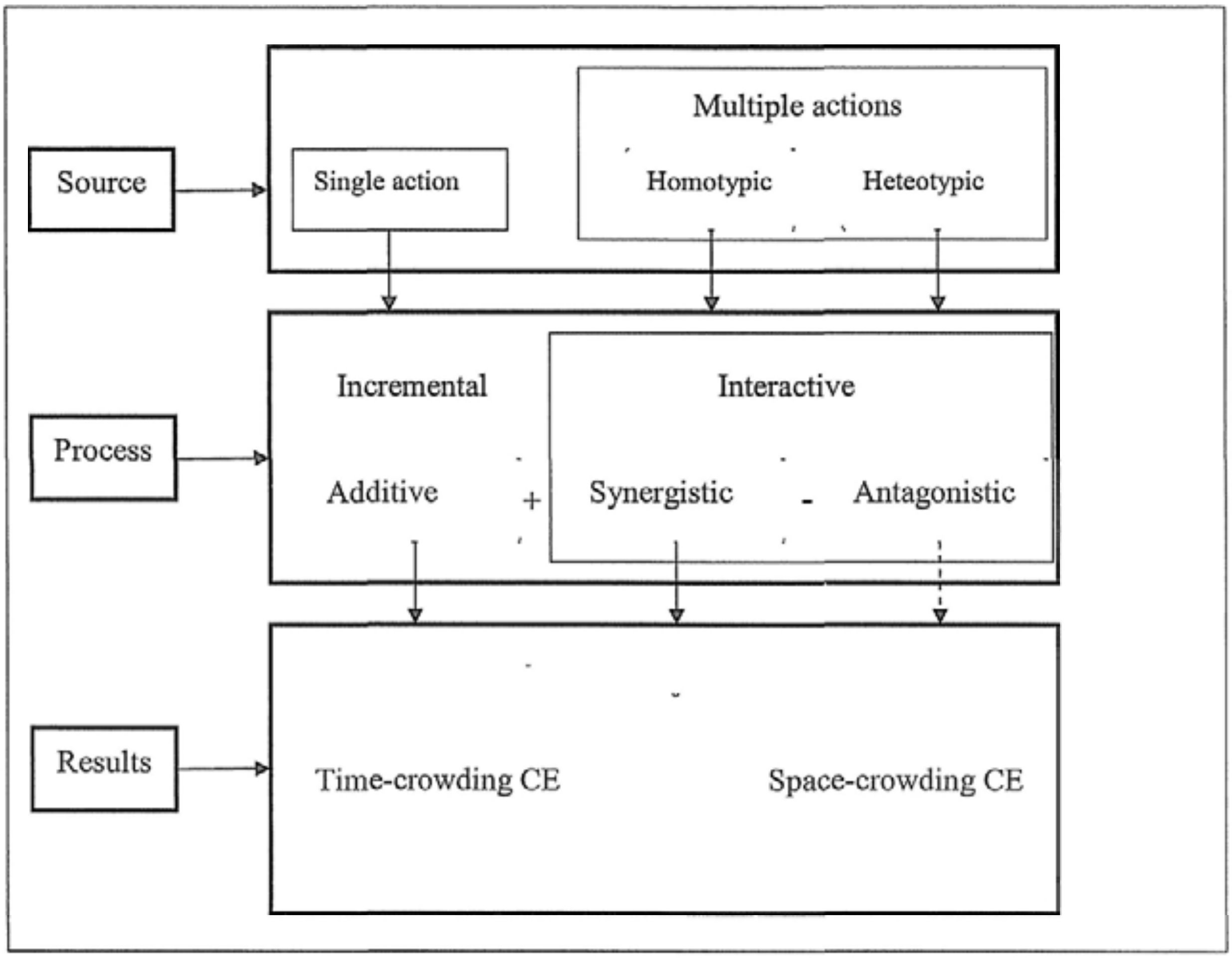

Fig. 2.4 Categories of Cumulative Effects

However, because of the recent concerns about the linkage between CEA and SEA, 'Project-EIA CEA' and 'SEA-linked CEA' have been or should be employed, stressing the CEA as an integral part of EIA, rather than 'Project-based' and 'Regional (Strategic)-based ' CEA. Of particular note, parts of the methods for

Project-based CEA or Regional-based CEA are still useful for Project-EIA CEA or SEA-linked CEA, although EIA-linked CEA, particularly SEA-linked CEA requires to prospectively predict the potential effects of proposals.

As mentioned in Chapter One, the ultimate purpose of this study is to develop a multi-jurisdictional SEA framework, suitable for watershed management in China. Large quantity of the involved projects and complexity of environmental consequences of watershed plans require the consideration of CEA and SEA. The linkage of CEA and SEA helps to protect and improve the environmental quality of a watershed as a receiving environment.

As João (2007) noted, scale issues are crucial for both project-EIA and SEA, which though are often ignored. Similarly, spatial and temporal scales are key factors influencing the regional size, the overall time period of cumulative effects and details or uncertainties in CEA outcomes. Therefore, 'Project-EIA CEA' and 'SEA-linked CEA' are to be discussed for the sake of the study in question, intending to present a framework linking CEA and SEA for watershed management. Because Therivel et al. (2007) have systematically compared their differences and effective applications in four main stages, according to the analysis of the scale issues, the subsequent several subsections are to be used to summarize the views by Therivel et al. (2007) about the limitations of Project-EIA CEA, the benefits of SEA-linked CEA, and the ideas about their integration, with some ideas from others such as Cooper et al. (2002), Quinn et al. (2002), Dubé (2003), João (2007) and others.

The emergence of CEA is to overcome the limitations of Project-EIA, which is also one of the main benefits of SEA. Project-EIA CEA tends to be proponent-driven (Quinn, 2002), which is the assessment of continuous and incremental environmental impacts caused by a specific project, especially those with repetitive nature and continuous effects, such as an industrial discharge system and a drainage networks. This CEA approach is of importance for integrating environmental considerations into the decisions of individual project proposal. However, the Project-EIA CEA alone without the context provided by SEA-linked CEA has many limitations.

1) Management Stage

CEA efforts should not end up with the prediction of cumulative effects, but should pay attention to the long-term management of the proposed actions. The management stage involves the following aspects: mitigation measures, follow-up and monitoring. In *management stage*, Project-based CEA tends to fail to address the regional coordination of multiple insignificant effects and also good management of the cumulative environmental influences is beyond the scope of Project-EIA CEA (Quinn, 2002). At strategic level, CEA is often government-driven. Better management measures are expected from SEA-linked CEA, due to the more forward-looking nature of government bodies than the project proponents and the early, overall integration of SEA into decision-making process (Sadler, 1995; Therivel, 2007). For example, Ministry of Water Resources, PRC and other government bodies responsible for integrated watershed plans of the Major Seven Rivers and the relevant SEA and CEA practices, China, have or should have the stronger power of harmonizing the interests of various sectors and neighboring administrative regions, despite the existent obstacles of water resources institutions in China. With this regard, SEA-linked CEA can serve as a management framework and an early warning system for Project-EIA and Project-CEA (Sadler, 1995; Quinn, 2002; Therivel, 2007). However, local protectionism or department protectionism compels the individual government to ensure maximizing their own local or sectoral economic interests. Therefore, both the proponent driving Project-EIA CEA and the government agencies driving SEA-linked CEA are subject to the same pressures from the marketplace (Therivel, 2007).

Finally, at this stage, of particular note is that an unsatisfactory effort in doing with cumulative effects at both project and strategic levels is attributable to 'apportionment of blame' problem in a large extent. Moreover, uncertainty of CEA outputs at all scales, which increases with scale (Sadler, 1995), is also a great hindrance for effectively managing cumulative effects and integrating the CEA outputs into SEA process and decision-making process.

2) Predicting Stage

When *predicting* the total effects of a project or a plan on a receptor, the inter-projects or the inter-plans effects should be evaluated, as well as the intra-project or the intra-plan effects (Therivel, 2007); however, only a very few SEA cases have considered inter-plan effects (Therivel, 2007). Any EIA and CEA outputs are associated with some uncertainties, which are related to the scales, as well as the technical complexity, the adopted methods, data availability and others. In predicting stage, uncertainties of CEA outputs at different levels show great differences. Generally, Project-EIA CEAs tend to be more certain than SEA-linked CEA; predictions of SEA-linked CEAs comparatively lean to be more *broad-brush and unquantifiable* due to uncertainties about the future development scenarios, the intricacy of the involved intra-plan or inter-plans sources, the difficulty of identifying temporal or spatial boundaries when predicting future activities. For all that, SEA-linked CEA should not be precluded, because 'a broad-brush picture of cumulative effects is better than no picture at all' and 'Half a loaf is better than no bread' (Sadler, 1996; Therivel, 2007). For predicting cumulative effects, 'expert judgment', 'causal chain analysis' 'modeling' and 'GIS techniques' have been adopted; collaborative and structured methods have obtained increasing devotions, especially due to the recent advances in information technologies (Quinn, 2002; Therivel, 2007).

3) Context determination (Baseline Conditions)

For predicting and mitigating potential cumulative environments, the environmental baseline of the receiving environment should be identified as frames of reference, together with the sensitivity of the valued receptors. The baseline data should provide the information of past, current, future activities and their effects on the receptors, especially the trends of past activities and the future changes of the trends. Also, the safe minimum standards of the receptors need to be clarified for comparing with target values, benchmarks and predicted effects (Sadler, 1995). When setting target values, trade-offs of different interests need to be balanced and the complexities of conflicts among various stakeholders increase with the CEA scales. Finally, for CEA of development proposals at large scales, for example, Integrated Watershed Plan of the Yangtze River, baseline studies should also involve the regional assessment of biodiversity conditions and landscape analysis of ecosystems.

Speaking for itself, Project-EIA CEA is much easier to describe the environmental baseline than SEA-linked CEA. In addition, the involved agencies and stakeholders for CEA are not difficult to be identified, particularly those for Project-level CEA. However, of particular note is that the involved organizations are not always adjacent ones and that the involved activities associated with impacts should not be limited to the immediate areas next to the examined area (Cooper, 2002; Therivel, 2007).

Maps at different spatial scales are often adopted for linking baseline description of all scales, particularly with the help of GIS and RS techniques. In addition, the 'topic papers' approach has been applied in a few UK SEA CEAs, which is receptor-based as an effective approach for determining the CEA contexts (Therivel, 2007).

4) Scoping

In many respects, scoping is the critical step for ensuring effective CEA in EIAs. It is to identify the receptors which will potentially lie under cumulative effects, to identify other relevant actions, and to set the spatial and temporal boundaries. Compared to project EIA, the scope of SEA is more appropriate to the temporal and spatial scales for assessing cumulative effects (Sadler, 1995) and the boundaries of strategic-level CEA is not easy to be defined (João, 2007). Generally, spatial dimension of CEA is defined more frequently and better than temporal frame; the temporal frame for CEA is seldom fully covered, mainly due to the limited availability of time series, the perplexity of determining reasonably foreseeable future actions (RFFAs) and the 'inherent difficulty in accounting for time-dependent processes' (Smit, 1995; Rumrill, 1997; Cooper, 2002). As for determining RFFAs (reasonably foreseeable future actions), Rumrill (1997) reviewed some exiting methods and presented a method.

In recent years, geographical regions such as watersheds have been cried up by CEA and SEA actors and academics, which is due to the easier identification of their boundaries, but more importantly which is due to the easier analysis of causal effects and influencing processes in physical regions than in administrative regions. However, current management efforts in geographical regions are still confronted with many resistances from administrative agencies. Of particular concern, whether the scales are too large or they are too small is not advisable.

As Therrivel (2007) noted, scale issues are poorly covered at both levels of project-EIA CEA and Strategic CEA. However, the management measures, the uncertainty for CEA outputs and the roles of CEA differ at different scales. SEA allows for better CEA than Project-EIA, by considering a wider range of cumulative effects at larger temporal and spatial scales (Therivel, 2007). However, both Project-EIA CEA and SEA-linked CEA play important roles in achieving the sustainability of proposals and regional developments, including watershed development. Moreover, Project-EIA CEA and SEA-linked CEA can compound for environment-friendly decisions. Consistency in data collection, assessment, and interpretation will establish a common base for the current environment of Project-EIA CEA and SEA-linked CEA.

A number of researchers and environmental protection agencies have developed the procedures and guidelines for undertaking CEA, which provides the heuristic bases for more systematically addressing local, regional and even global cumulative implications (Sadler, 1995; Smit, 1995; Therivel, 2007; CEEA, 2004). The various steps of CEA processes developed by different academics and agencies fall into one of the four groups, i.e. the above mentioned four main steps: scoping, context description, prediction and management. Selection of CEA steps in practice, together with appropriate methods, depend on data availability, the CEA scales, the key components and issues of the receiving environment and otherwise.

(3) Methods for assessing cumulative effects

CEA is a process with a set of tools for systematically evaluating the cumulative changes of the environmental and social-economic system associated with the proposals (Smit, 1995; Quinn, 2002; Dubé, 2003). So far, a wide range of methods have been developed, tested, applied and evaluated for CEA, such as expert consultation, checklist, matrices, networks, system flowcharts, mathematical models, environmental carrying capacity, overlays, and scenario analysis (Sadler, 1995; Smitt, 1995; Wärnbäck, 2009). Selecting one sound method from them is indeed challenging, for obtaining the reliable CEA outputs. Early researches focused on the application of the traditional Project-EIA methods, such as matrix methods and network analysis, and later, approaches specific to regional or strategic CEA have received increasing attention.

Classification of CEA methods is mainly based on dichotomy, such as 'Project-based' and 'strategic' (Quinn, 2002), 'list of projects' approach and 'summary of projections' approach (California Environmental Quality Act), 'analytical' and 'planning' approaches (Smit, 1995; Wu, 2007), 'impact assessment approach' and 'planning approach' (CEQ, 1997) or trichotomy, for example, 'matrix methods', 'causal Analyses methods' and 'meta-modeling' (Smit, 1995), 'ex ante methods', 'monitoring methods' and 'posterior or hindsight methods' (Smit, 1995). The prevalent methods in the literature include Checklist (Canter, 1995; Heathcote, 1998), Matrix (Canter, 1995; Heathcote, 1998; Wärnbäck, 2009), Network (Canter, 1995; Wärnbäck, 2009); Questionnaire (Smit, 1995; Wärnbäck, 2009), Scenario Analysis, Landscape analysis (Smit, 1995), GIS (Smit, 1995; Canter, 1995; Heathcote, 1998; Blaser, 2004; Wärnbäck, 2009) and Collaborative methods of combining part of them (Canter, 1995; Heathcote, 1998; Quinn, 2002). Finally, the numerous methods are also carved up into those respectively for screening, scoping, predicting them, and illuminating the predicting results of them, specific to each stage throughout the CEA process.

Effective assessment of cumulative effects eventually lies on the cautious selection and proper application of individual methods, techniques, and tools. No universal and standard methods could be adopted for assessing all cumulative environmental implications, requiring to consider the nature of the proposals or underway decisions, the key environmental components of the affected region, the availability and precision of information and data, the time limit and financial budgets, and the specific stage of the CEA process (Sadler, 1995; Smit, 1995; Canter, 1995; CEAA, 2004).

For example, at the screening stage of deciding whether a CEA should or need be undertaken, matrices or check lists is often applied with the help of consultations. For scoping of CEA, no specific methods or techniques are available, so the scoping processes in practice are usually at hoc and informal, particularly at strategic level. Matrix is a usual method for scoping. Currently prevalent prediction methods include the cause-and-effect analysis, modeling, landscape analysis, as well as expert judgment and consultation. Although quantitative analysis of potential cumulative effects is more and more desirable, qualitative outputs are essential, especially for SEA-linked CEA and project-CEA of large scales, due to their more uncertainties. Furthermore, the spatial analysis function of GIS helps to exhibit the spatial characteristics of cumulative influences and the linkage of GIS and CEA modeling hopefully is one of the future methodological focuses.

Referring to the CEA methodologies, Smit et al. (1995), Canter et al. (1995), Dubé et al. (2003) systematically analyzed some cases and characteristics. Among them, Canter et al. (1995) developed a generic questionnaire checklist for summarizing cumulative effects, which can be seen as a beginning of systematic CEAs and also be used by selecting appropriate items in it according to the proposal's nature. In addition, some methods are mentioned by Therivel et al. (2007), based on the comparison of Project-based CEA and Strategic CEA. Due to the extension of temporal and spatial scales outside the proposed regions, the methods of CEA, especially those applied for SEA-linked CEAs, tend to be more complex than those for general impacts.

2.1.4 Public Participation

Here, public participation is a process allowing stakeholders, non-government organizations (NGOs) and media, as well as experts and government agencies, to take part in the whole SEA process and even the decision-making process. It has been required as a key component of SEA for improving the quality of the SEA process and assuring its smooth performance in many countries. For example, the 2003 EIA Law has a simple mention about public participation and there is a chapter about public participation in each EIA report in China.

(1) Necessity

It is favored by the academics and practitioners. One reason is that the stakeholders can provide more information for the SEA process, due to their actual experience facing the various consequences of the actions and using various resources. In addition, the mass media and NGOs generally encourage or compel the government agencies or proposals to harmonize the trade-offs between different groups of interests. Thirdly, the proposals and the proposal-makers tend to more easily win the support from the public, if the public's opinions have been integrated into the SEA process. Thus, the effective communication between the public, the SEA actors and the decision-makers help to increase the SEA transparency and ensure the smooth performance (Ren, 2005). Of particular concern, the public should not be limited to a phase of SEA, but should be continuous and iterative through the whole process, and even should also be allowed for supervising the implementation of the SEA outputs at follow-up and monitoring stage after the decision has been made.

(2) Modes and Methods

Since its emergence in the 1970s, various modes of public participation have been applied: hearing, expert judgment, consultation and negotiation. For any mode, information distribution into the public and receiving the feedback from the public combine to be the base of public participation (Ren, 2005). The prevalent tools for distributing information include brochures, news bulletin, newspapers, broadcasting and TV, and fieldwork. As for information feedback, public hearing, questionnaire, interview, online survey, public meeting and workshop are frequently adopted in many cases.

However, different proposals deal with different stakeholders and require different professional knowledge. Thus, the selection of appropriate modes should be cautious, according to the nature of the issues associated with the proposal. For example, Pu (2007) introduced the revised Vroom—Yetton model for choosing the participatory way from the following four ones of consultation, hearing, expert panel discussion, and '*multiparty*' negotiation.

(3) Limitations and public understanding

Public participation does not play its deserved role in many countries. Limited public participation is often one of the main criticisms in most cases, especially in developing countries.

Low information availability, faulty regulations and laws, improper participating way (e.g. only online publicity of the EIA report in the associated official website exists for the public) and public understanding are impeding the effective participation. For example, indigenous people with low education levels have no enough capacity of comprehending causal mechanisms in decision-making process and SEA process, due to complex technical terminology. In addition, lack of community resources, language barriers, and even regional beliefs are also confining their participation capacity. Again, the unfair or random selection of the participants without regard to the backgrounds of the participants tends to ignore the voice of vulnerable groups and their interests. Moreover, the questions designed for the public involve too many impenetrable technical terms to be easily understood (Ma, 2006). Even some EIA agencies devise the similar questions or there is 'a change in form but not in content' for various EIAs. Last but not the least, the advices from stakeholders, especially those venerable ones, are not always considered, or even are waved aside, due to the opposition from more powerful forces. Thus, their interests are often conquered by more powerful interests (Kende-Robb, 2008).

Public understanding of the environmental impacts has been studied in different contexts, which is 'dependent on diverse influences along an individual-social continuum' (Sherry-Brennan, 2009), including the participatory mode, the availability, accuracy and clarity of information, public knowledge, the nature of the proposal, especially the relevance of the public's professions to the proposal. However, most questioners focus on the political supports to and the legal requirements for public participation, as well as participatory consciousness; few specific reports on public understanding of the environmental impacts and public motivations. Therefore, public understanding should be paid enough attention to, as well as political and legal support to public involvement, so as to enhance their participatory capacity. Moreover, it is deserved to be concerned how to improve the clarity and understandability of distributed information and data, in order to boost public understanding, public acceptance and their participatory capacity. In Chapter Five, public understanding and their participatory capacity in China, especially for watershed management, will be explained in detail. As well, the Vroom—Yetton model is suggested to be referred to and revised, for identifying the appropriate mode of public participation in watershed management.

2.1.5 SEA Contexts

National contexts and political games play critical and crucial parts in striking a balance among social, economic, environmental and other objectives (Sadler, 1996). The profound political commitment to environmental protection and sustainable development is the overriding determinant of improving the effectiveness. The review of EIA effectiveness, including SEA effectiveness, and EIA performance criteria is context-specific (Sadler, 1996; Hilding-Rydevik, 2007; Retief, 2007; Nobel, 2009; Nykvist, 2009; Runhaar, 2009). As Hilding-Rydevik et al. (2007) noted, the need to understand the SEA contexts and to adapt SEA to contexts for ensuring effective SEA implementation has been recently highlighted by some academicians. That's because the legal, administrative, political and cultural circumstances influence the participants involved, the selection of SEA approaches, the SEA process, the interpretations of the SEA outcomes and the extent to which SEA outputs are integrated into the decision-making process, as well as the decision of conducting SEA or not.

(1) General Definition of Context

As for the concept of 'context' in which SEA is undertaken, Hilding-Rydevik et al. (2007) presented a general definition: 'context' is the set of circumstances and backgrounds that have impacts both on the selected 'approaches' for SEA and on the 'outcomes' of implementing SEA. In this definition, they included the following aspects in 'approaches': 'the chosen aims and goals' related to SEA, the expectations on SEA implementation, the appointed procedures and steps, and the adopted methods. In terms of 'outcomes', they referred to the impacts of SEA on the decision-making process, on the involved participants, on the operating mode of the involved organizations, and on the contents of the proposal. The elements of the above 'approaches' and 'outcomes' can be used as the indices of evaluating SEA performance and effectiveness, within the specific national and decision-making contexts.

(2) Elements of Contexts

Every SEA case has its own unique set of contexts, depending on the related particular sectors, the administrative regions in which SEA is undertaken, the involved stakeholders and the key receptors. As Hilding-Rydevik et al. (2007) identified, the specific elements of context in relation to SEA should be identified according to the nature of the specific proposal; the elements of contexts associated with SEA for regional development plans are shown in Fig. 2.5, which include 'national policy style, characteristics of the planning agency, planning style and political commitment to SD' at macro-levels and 'receptivity' to SEA results at micro-levels. The former set is mainly related to the national legal-constitutional system and the administrative set-up; from the stump, the latter set is chiefly influenced by social cultures (Hilding-Rydevik, 2007). Similarly, Nykvist et al. (2009) classified the elements of context into three levels: macro-, meso- and micro-levels. The elements at the Nykvist et al. (2009)'s meso-level include organizational procedures and management structures, which are equivalent to 'the characteristics of the planning agency, planning style and political commitment to SD' in Fig. 2.5. However, it should be noted that 'there is no consensus about what constitutes context' (Runhaar, 2009). All of those shown in Fig. 2.5 are hackneyed context variables.

For an integrated watershed plan in China, specifically, the elements of contexts include the watershed management system, the water resources management and allocation institutions, and the PEIA system, as well as the above-mentioned general national operating procedures. They will be illustrated in depth in Chapter 4, mainly including the legal and institutional arrangements.

(3) Importance of Context Awareness

Context-free procedural theories and methods have long been criticized (Hilding-Rydevik, 2007; Retief, 2007). The SEA cases in a political vacuum have been proved unsuccessful in many countries. In recent years, more academicians and actors have paid increasing attention to context awareness, notwithstanding it is not explored and addressed in greater details (Hilding-Rydevik, 2007; Runhaar, 2009). The choice of various crucial steps, methods, assumptions and interpretations of outputs should depend on the specific context where SEA intends to be undertaken (Hilding-Rydevik, 2007; Retief, 2007). One reason is that the elements of context possibly influence the specific role of SEA implementation, improving the planning system or providing EA information or promoting sustainable decision-making process (Hilding-Rydevik, 2007; Runhaar, 2009). Therefore, 'insight into these elements helps getting a better understanding of how SEA contributes to decision-making' (Runhaar, 2009). Moreover, another reason for concerning the underlying context knowledge is that elements of contexts in turn reflect the different expectations on the SEA outputs. Different nations, regions and sectors all exhibit the differences in the elements of context. For example, the application of SEA in watershed planning systems is still in its infancy and well-developed legislations and guidance are not in place in most countries, especially in developing countries; however, there are well-regulated procedures and complete legal prescriptions in the land-use sector and the transport sector, especially in developed countries.

Although it is crucial to consider the specific elements of context when conducting a particular SEA, it can't be reached in one move to promote long-term changes in the national political system, the legal implementation, and social norms, which is the offspring of the continuous conflicts between various social forces. It is ridiculous to ask the decision-makers and their government agencies to change suddenly the national polity, administrative institutions and the cultural norms. Moreover, for improving the SEA practices from various perspectives, it is not advisable to copy the theories and methods from other regimes and other sectors. Therefore, the context-specific SEA system and guidelines need to be developed and adapted, within the unique national regime and the particular sector, together with gradually creating more favorable contexts.

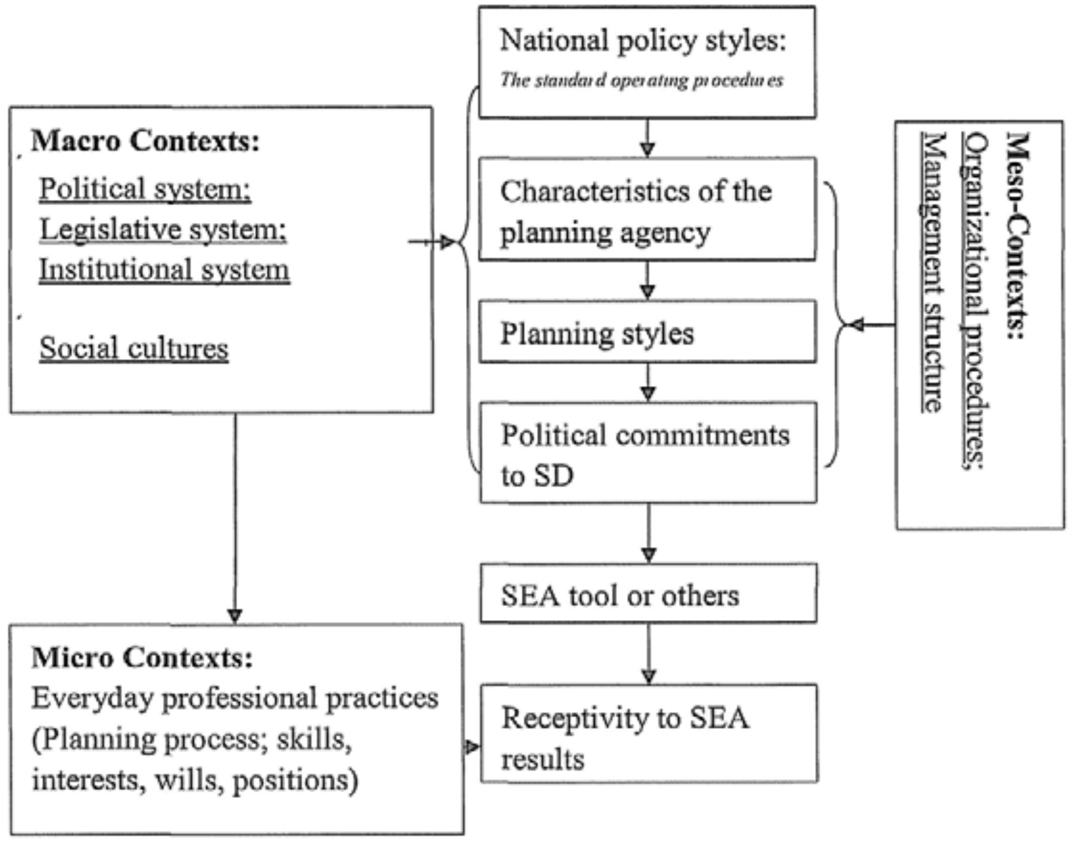

Fig. 2.5 Contexts and elements associated with SEA for regional planning

(Modified from Hilding-Rydevik et al., 2007)

2.1.6 Uncertainty

No matter how scientific and rational the environmental assessment process is, the EA outputs can only be supposals until all the involved projects and actions in the watershed under discussion are actually in place. 'The further into the future these impacts are assessed, the less accurate the predictions become' (Heathcote, 1998). That is to say, uncertainty associated with SEA and CEA is always unavoidable. However, uncertain EA outputs should not be an excuse of proceeding to take actions with significant negative environmental potentials and postponing the mitigating measures (Heathcote, 1998).

For a proposal and its alternatives, a decision whether to accept the proposal or one of the alternatives or to reject all of them needs to be made, based on the CEA or SEA outputs. The necessity of a decision implies some uncertainties, because the future is '*an unknown quantity*' and each assumption about the future is dubious (HAL, Uncertainty Analysis Process). The proper treatment of uncertainty, such as incorporating uncertainties into models to help assessing potential risks, has aroused the concerns in EIA cases, including SEAs (Darbra, 2008; Linacre, 2005).

(1) Sources of uncertainty and Categories

Various sources have been identified. For instance, the following reasons may lead to uncertainties in SEA: the natural variability of the environment, the unsureness about the future environment, limited rationality, limited data availability, the imprecision and inaccuracy of data, the imperfect technologies and their changes, social-economic variability, changes in political and economical priorities, unanticipated changes in actions, the involvement of other actions or proposals, simplifications of models, errors in CEA and SEA, changing interpretations of SEA outcomes, changes in judgment values (Modified from João, 2007). Here, uncertainty is to be analyzed in depth based on the four categories: objective uncertainty and subjective uncertainty, or uncertainty in process, and uncertainty in game theory.

1) Objective Uncertainty

Here, objective uncertainty is often associated with the inherent dynamic development and intrinsic variability of the environmental system. For example, in a proposed watershed, rivers, plants, animals, human activities and other various factors interact to change continuously the watershed system. However, information and data about environmental baseline are often related to the past or current system and when the decision is made, the system in every stage of CEA is distinct from the past one. Thus, the predictions of SEA and CEA need to be iteratively revised for adapting to the changing baseline.

This kind of uncertainty is universal in various watershed managements. It consists of two aspects: the random uncertainty and the systematic uncertainty (Mikhail, 2002). Regardless of any efforts, it is impossible to control, overcome and *precisely* identify them, particularly random uncertainties. However, ample experiences and rich professional knowledge about the random or systematic process inherent in the proposed system, such as a watershed, help to identify and reduce such uncertainty in the SEA and decision-making process. Moreover, the larger the spatial and temporal scales are, the more complex the system is. Thus, environmental systems of larger scales generally are more uncertain than those of smaller ones.

2) Subjective Uncertainty

For the SEA process of one certain proposal, various outputs are obtained by different groups of actors. Therefore, subjective uncertainties are attributable to the differences of *limited rationality* and *cognitive mode* between individuals or various groups. For example, the mindsets of decision-makers and learning capabilities of the actors are important for the decision and its future consequences. Moreover, different experiences, different professional knowledge, different levels of education and especially various interests and powers may combine to lead to the uncertainty of the SEA outputs.

The real existence of spatial information, ecological environmental information and others is objective. However, the orientation, collection, storage, processing, and analysis are always dependent on the interests and techniques of the data collectors, analyzers and users. Moreover, no all information need or can be brought into the data base, which, at maximum, could approximate only a fraction of the real world. That is to say, there is only a *limited rationality*, although it will evolve continuously to approaching the reality. In addition, the technical or theoretical limitations in sensors and models can't ensure the accuracy and precision of all data. Part deletion or rejection of the available data base is also possible during the decision-making process. Thus, the uncertainty of data and information occurs, which in turn affects the uncertainty of the outputs. Finally, lack of guidelines and systematic requirements lead to informal or at hoc procedures and even different aspects in the final documents of similar proposals.

For reducing this dimension of uncertainties, international, interdisciplinary and inter-sector cooperation is desirable. The *multi-party* cooperation may be beneficial to avoiding the unilateralism caused by *individual party*. In addition, effective public participation can assist in collecting comprehensive information from different aspects. For example, the participation of indigenous residents helps provide the first-hand information about the consequences of the proposal or their experiences, which could be used to analyze or identify the environmental effects of past activities. Thirdly, to enhance the proficiency of all actors, to improve the theoretical researches about SEA and CEA methods, as well as environmental managements, and to select proper tools in each stage can effectively cut down the uncertain degrees of the outputs, such as uncertainties of CEA results. Finally, the development of internationally general SEA guidelines and standards for each sector is necessary, with the support of experts from various disciplines and domains, for guiding and regulating the practices.

3) Uncertainty in process

In this study, this type of uncertainty occurs in the SEA process and its implementation process. At all stages of SEA process, unexpected changes or occasional events or emergent events are potential and even ambiguous trends can't be detected (Postma, 2005). With their intervention, the cause-and-effects and the interactions between different spatial parts and different receptors in the receiving environment are often fuzzy, which makes long-term predictions uncertain or worthless. In addition, time-delay of information or act of God can also bring uncertain implications, so that the present environmental system can't reflect the changes immediately when they occur.

Therefore, decision-makers should reduce the uncertainties, especially 'large probability uncertainties', by giving more insight into the environmental system, the complex interactions between various impacts, and the stages of the process. Enough preparations are also necessary, so that all potentials are beforehand considered at full length. In addition, as explained above, coordination between international agencies, various sectors, government agencies of different levels and a variety of disciplines and broad public involvement provide opportunities for more enough environmental information, and more credible knowledge, techniques and tools, so that frequencies, time frames, forms and their potential influences of chance events can be identified or at minimum realized.

4) Uncertainty in game theory

Game theory has been playing an important role in operational research. In recent years, it also has appeared in some literature about environmental management. Literature introducing *game theory* into water resources management was available in 1980s.

Rationally, game theory mainly talks about interactive decision-making processes, which means that the conflicting or cooperating parties or players try to make a strategy or decision maximizing their own interests by interacting with each other and integrating the decisions of others into their own (Shyba, 2006). Thus, an optimum strategy should occur, based on the assumption 'egoism', without the intervention of more powerful authorities. However, in the real world, the decision-making process is also influenced by social factors, political contexts and psychological states of decision-makers or participants. For example, the development of behavioral game theory, the prevalent elite politics and winner-takes-all governance have smashed the fancy of Rational Game Theory, especially the Nash Equilibrium.

Development, assessment, examination and approval or cancellation of each proposal, especially higher-level ones such as integrated watershed plans, all involve various stakeholders and conflicting interests of groups. The conflicting nature between them often leads to the unfair and unequal treatments of their voices. Generally, the vulnerable have no or very feeble voice in the elites-capture games of decision-making, due to asymmetric information and imbalances of power. Regardless of the increasing attention to public participation, the transparency of decision-making process is still difficult to extend beyond elite circles (Blair, 2008).

The involvement of a sector, or an agency or even individual elite may significantly influence the uncertainty in political or economic games. Wane and wax of various interest groups possibly readjust the distribution system of costs and benefits. For addressing this kind of uncertainty, it is necessary to develop transparent guidelines and decision-making procedures, which should be enforced to be followed for all 'players'. Here, for SEA process specific to watershed management, those guidelines and procedures can be seen as the 'game rules' in decision-making process. The evolving public participation and various collaboration in many SEA cases also help promote the balance of the trade-offs between all 'players', aiming to replacing 'elite politics' and 'winner-takes-all politics', although all the past efforts are still dissatisfactory.

There are some overlaps between the four categories, because they don't depend on single criteria of categorization. Here, in SEA for integrated watershed plans, there are complicated uncertainties, due to the involvement of various specific plans, the large scales of time and space, diverse impact mechanisms and their interactions due to 'water-related transport of sediment, woody debris, chemicals, heat, flora, or fauna' (Reid, 2001). Uncertainties in watershed-PEIAs mainly include four types: uncertainties of watershed plans, uncertainties of PEIA indicators, uncertainties of the involved engineering projects, and uncertainties of the discharges. For simplicity, the uncertainties can be categorized from another perspective, i.e. the sources of uncertainties in SEA for watershed plans, which include uncertainties of integrated watershed plans, uncertainties of environmental information, uncertainties in SEA and CEA predictions (Luo, 2009).

(2) Characteristics of uncertainty

According to the foregoing analysis, uncertainties are characterized by universality, transmissibility, cumulativity, and reducibleness (Luo, 2009). Uncertainties lie in all proposals subject to decision-making. Each proposal about watershed management doesn't make an exception. The uncertainties in environmental information surely influence the assessment of cumulative effects and SEA process and even increase the uncertainties in the SEA outputs and the decision-making process, which respectively present the transmissibility and cumulativity. Although uncertainties are universal, the identification and reduction are possible. The promising measures for addressing and reducing uncertainties in SEA processes will be explained in the subsequent subsections.

With the reinforcement of intercommunion and the continuous development of globalism, there are two opposite trends in uncertainties. On one hand, more knowledge about the uncertain factors has been or will be obtained and also relevant new tools for dealing with uncertainties have been developed. On the other hand, the increasing developments may increase the complexity of causality relationships and may speed up changes in one environmental system, which leads to more ambiguities and uncertainties, together with the influences of more interweaving sociopolitical and cultural environments.

(3) Measures for Addressing Uncertainty

As shown above, uncertainties may be introduced by imprecise and insufficient environmental data, dynamics of the environmental system and conflicts among 'players'. Uncertainties occurring in SEA processes, especially uncertain SEA outputs, often make the decision-makers face a difficult dilemma with some risks.

'Risk will be a function of the uncertainties' (Reneke, 2009). Uncertainties related to CEAs may confuse the decision-makers and lead to the difficulties in conceiving the opponents of the conclusions. Therefore, proper tools and instruments need to be adopted for addressing uncertainties as possible as we can, such as clarifying all assumptions (João, 2007), identifying environmental potentials by probabilities and ranges rather than precise numbers (HAL, Uncertainty Analysis Process; João, 2007; Reneke, 2009), scenario analysis (Luo, 2009; João, 2007; MRC, Strategic Environmental Assessment Methodology and Techniques), public participation and multi-party corporations (Luo, 2009; MRC, Strategic Environmental Assessment Methodology and Techniques). Fuzzy Set Analysis is another prevalent method dealing with uncertainties (Reneke, 2009).

1) Probability Approach

Probability is often used for precise representation of uncertain situations, which here measures the confidence levels of environmental potentials coming true (HAL, Uncertainty Analysis Process). It quantifies uncertainties by introducing statistical probability distribution, which is associated with Bayesian Theory (Reneke, 2009). When applying this approach, the decision-makers need to make some subjective assumptions about uncertainties, which in turn increase uncertainties in some degree (Reneke, 2009).

2) Scenario Analysis

Multiple-scenario Analysis has been advocated as an effective method in dealing with uncertainties in environmental management cases, by offering managers several future perspectives and comparing their consequences. However, it is unable to address complicated development proposals and entirely unanticipated trends, due to their high environmental turbulence in scenario-building processes, which is a deficiency inherent in this method (Postma, 2005). In cases of integrated watershed planning, this method is often applied for predicting and comparing the environmental implications before and after the implementation of the proposal or its alternatives. Scenario analysis provides a framework for SEAs, but constructing scenarios need the support of other tools and methods, such as GIS, models, landscape analysis and so on.

Various approaches for scenario analysis have been developed. However, there are no standard process and procedures for all. Postam et al. (2005) presented the general phases of a scenario process, which includes identification of the focal issue or decision, key forces in the receiving environment and driving forces, ranking them by importance and uncertainty, selecting the scenario logics, fleshing out the scenarios and implications for strategy, selection of leading indicators and signposts, feeding the scenarios back to those consulted, discussing the strategic options, agreeing the implementation plan, publicizing the scenarios. They also suggested three ways for constructing scenarios: recombinant scenarios, context scenarios and inconsistent scenarios.

3) Public Participation and Multi-party coordination

Due to cognitive limitations, any people or any groups or even the humankind can only apprehend part of the real world and its future possibilities. However, many hands make light work; the participation of stakeholders and experts from different sectors and disciplines redounds to providing more knowledge and information about the receiving environment and the future uncertainties of proposals to be decided.

2.2 Theories of Watershed Management

2.2.1 Introduction of WM and IWM

Here watershed means the drainage basin, which is 'an area of land within which all waters flow to a single river system' (Heathcote, 1998), and which is 'a dynamic and integrated social, economic and biophysical system' (Baloch, 2008). A Watershed approach has been used by watershed organizations for water management since the late 1980s (US EPA, 2008). Many cases are available, such as those in the Mekong River Basin of Southeast Asia, in England, Whales, Scotland, and Northern Ireland of UK, in the Mississippi River Basin and others of US, the River Basin Planning Act of Georgia and the Europe Union Water Framework. There has been 'a clear global consensus that watershed is the most appropriate agency for water management' as a natural system (Heathcote, 1998), which provides 'the spatial tool necessary for effective research, assessment, and management of environmental systems' (Baloch, 2008).

(1) Necessity and Challenges of Watershed Management

Watershed management initiatives often involve efforts on the governance of water resources, aquatic habitats and ecological systems throughout the watershed (but not exclusively) and their concerns on the management of economic and social elements have been in growth as well as biophysical ones. The replacement of the political region by the watershed as a framework for managing water and other resources has gone through several stages (Gourbesville, 2008). Its concept 'has experienced at least two transitions' from its initially orienting 'toward the control of water supply and use' to 'a concern for water quality and the combined effects of land use in the drainage basin', and then to a new attention to recognizing watershed 'as a more-or-less workable surrogate unit of ecosystem management'(Nelson, 1998).

Many reasons, which have been mentioned by some researchers (Mance, 2002; Gourbesville, 2008), can be used to explain why there is a recent tendency toward adopting 'watershed' as a framework for resource management. Watershed is a multiplex system with multiple levels and functions. Hydrological cycles in the watershed are the controlling factors influencing ecological environments and the common crux of various water issues and ecological issues. In a watershed, a hydrographically coherent region, the activities, natural or human, are interactive with and even dependent upon each other through water flows (Gourbesville, 2008). With this in regard, watershed-based trade-offs and allocation of natural resources among the actors are more accountable, so that the conflicts between them are easily and readily to be harmonized. The watershed's natural boundaries have physical relationship with hydrological and ecological processes. Thus, those physical processes could help consider the integrated nature of water and other factors, the cause-effect relationships between activities and their consequences, the interactive characteristics of various activities between the upper, middle and lower reaches, between the two sides of river channels, and between different administrative regions. Moreover, the watershed-based management could keep the integrity of the hydrological processes and the ecological functions in some degree, which results in the benefits of systematically assessing the cumulative effects crossing the administrative boundaries. Therefore, for fully realizing the comprehensive environmental consequences, both upstream and downstream, both left and right bank, both surface water and ground water should be considered together, rather than be fragmented by administrative divides. However, successful watershed management cases remain missing in many nations or regions.

Watershed-based management plan, as one new approach to environmental management, is more challenging than traditional engineering measures and administrative planning options. The main challenges faced by any collaborative planning process include inclusion of all stakeholders, integration of all involved issues, scales and processes, delivery of planning outcomes, and effectiveness, which are shared by the watershed planning process (Blackstock, 2007). Besides the common challenges, watershed management in China has also its own context-specific ones.

Gourbesville et al (2008) summarized the main conflicts in watershed management, which include those 'between top-down and bottom-up approaches', 'the holistic philosophy' behind integrated watershed management (IWM) and 'the participatory ideal of decentralized decision-making', 'the science-based' or technocratic approach and 'community-based initiatives', 'watershed management institutions' roles respectively for allocating 'an increasingly scarce and finite resource' and for mobilizing 'developmental resources and funds' to utilize more resources. Moreover, the conflicts between administrative management and watershed management of water resources and other related natural resources are also need to be noted.

Among various endeavors on watershed management, IWM has more benefits than the single-purposed one, which has been in the limelight in many countries for managing water quality, water quantity and ecosystems within the proposed watershed. IWM is a process of managing diverse environmental components in a watershed system under the context of sustainable development. According to Heathcote (1998), it is a watershed-based management intending to 'integrate water quantity and quality, natural (environmental impacts) and human (social impacts) systems simultaneously and even consider costing and legal, institutional and administrative concerns', which is different from other similar terms such as 'integrated water resources management' and 'comprehensive river basin management'. Those similar ones 'are usually restricted solely to water quantity' (Lee, 2008). The integrated approach assists to incorporate the full range of values and perspectives associated with water management (Heathcote, 1998), as a way of overcoming the fragmentation of multi-value systems. The integrated and trans-media consideration of water, land, and other biophysical resources in the receiving watershed provides a way for fully assessing cumulative effects and ensuring minimum cumulative negative environmental consequences.

Moreover, the integrated watershed strategy 'suggests a more interactive and interconnected approach' for considering the variety of environmental components (Baloch, 2008), and, if effective, helps the proper allocation of the natural resources, and assists to harmonize the relationships between interests or sectors in watersheds during its step-by-step process. Moreover, the gathering and sharing of watershed management knowledge resulted from the collaboration among disciplines and sectors. Therefore, the stakeholders tend to have more integrated information about watershed management by being consulted in the decision-making process.

Various implications exist in 'integrated' (German, 2007). The governance of watershed development needs the collective efforts of multiple experts, multiple users, multiple stakeholders, multiple value systems and multiple decision levels, due to the interactive nature of different parts in a watershed (Gourbesville, 2008). Therefore, here it emphasizes the integration of various scientific, technical and engineering disciplines (hydrology, environmental sciences, ecology, biology, chemistry, physics, landscape, statistics, GIS and RS technology, sociology, not exclusively), or various dimensions (social, technical and institutional), or different objectives (flood prevention, hydropower, water supply, water and soil conservation) or various actors or all kinds of sectors (population, land use, agriculture, industry, climate, water supply and demand and others) or biotic and abiotic elements or surface and ground water. Only when involving all elements or components of the whole watershed, sustainability of watershed developments could be possible.

Integrated approaches to watershed management have been proposed for remedying some problems that piecemeal/single-purpose approaches, such as traditional engineering responses, fail to solve (Lee, 1995; Mance, 2002). However, few real attempts have been made on operational approaches, besides several in EU and USA. Some challenges, particularly the institutional deficiencies, haven't been fully grappled with in some parts of the world. In addition, IWM has more barriers to be overcome and has more uncertainties than single-purpose watershed management. At present, few successful IWM cases are available for reference and research at home and abroad, especially lacking effective IWM cases at larger scales such as the international scale and the global scale. One important reason is that the managements of water quantity, water quality and other environmental components are often respectively subject to different agencies in some nations (Heathcote, 1998). The conflicting authorities of regional and watershed agencies make their coordination very difficult, which is often more arduous with the participation of the external agencies, such as the World Bank and the Asian Development Bank (Heathcote, 1998). In China, the documents associated with IWM are not easy to be obtained. Therefore, several single-purpose watershed planning cases are also selected for case study, as well as two cases for integrated watershed plans and their SEAs.

(2) Watershed Planning and Regional Planning

A watershed plan is a strategy that provides assessment and management information for a geographically-defined region, watershed (US EPA, 2008), which is a popular type of water management. It is also one special type of regional planning, based on the natural boundaries rather than traditionally-used administrative boundaries. Both watershed planning and regional planning include two types: integrated and specific planning, both intending to ensure the proper utilization of natural resources and promote the sustainable development. However, in general, regional planning is based on politically-determined boundaries, which bears little relation to natural ecosystem process (Baloch, 2008; Gourbesville, 2008). Watershed-based planning adopts the watershed as the basic unit for managing natural resources, economic developments and social activities, tending to integrate physical, chemical, biological and social process into a more holistic system and assisting to combine human process and natural process (Mance, 2002; Baloch, 2008).

Regional planning focuses on the need of the economic development and ecological protection in administrative regions. Watershed planning places much importance on the coordination between the tributaries and the main channel, between the upper, middle and lower reaches, between various land usages, between water resources and ecological protection in the entire watershed. Inevitable and unmanageable conflicts exist between them, due to the different focuses and interests of regional planning and watershed management agencies, and their different covering spaces. For example, the linkage between lakes and rivers should be kept for protecting the ecological systems in watersheds. However, regional development needs the constructions of flood locks at the sites between lakes and rivers. In general, one large-scale watershed may include several provinces or other administrative regions. In this case, regional planning should be subject to its associated watershed planning. In contrast, some small-scale watersheds or part of them may combine into one administrative region. For example, Fujian province in China has many small-scale watersheds, whose planning contents should comply with the requirements of the Fujian's Regional Planning.

(3) Watershed Planning and Specific Planning/Industry Planning

In a watershed, various sectors and political regions compete against each other to utilize water resources and other natural resources. These sectors often establish relevant specific planning /industry planning for maximizing their own interests, but generally losing sight of the integrated interests or the gains of other sectors.

Those specific plans could also influence many facets of the watershed system, among which land-use plan is particularly true (Heathcote, 1998; Carter, 2006). The activities in those plans may change the characteristics of the watershed system by different ways, such as by altering the landscape and land cover, or by changing the water movement, or by influencing the pollutant yield and the biodiversity. Here, land-use planning is a remarkable example. Generally, almost each aspect or component of the watershed system is not inseparable from the previous, current or potential developments proposed in land-use planning. For example, land-use and land-cover changes in a watershed, even minor changes, may have significant implications for or have dramatic impacts on other major components (water, soil, climate, biological communities and human communities), various processes (including the physical, chemical, and biological processes), and various functions (especially for hydrological processes and functions). Therefore, the linkage of watershed planning and land-use planning is desirable, similar to the integration of

WFD and SEA Directive. Moreover, their conflicts need to be harmonized, because of different boundaries and different focuses.

Another example is power development planning. Individual heat power stations often belong to different power companies; therefore, no EIA for an individual station could consider the cumulative effects of the thermal drainage, caused by all those stations. Even for those PEIAs for development of heat power, the cumulative effects of the development plans for heat power prepared by different power companies are still not under full consideration, not to mention the trade-offs between power companies and watershed planning agencies with multi-purpose and multi-factor considerations.

Moreover, there are also conflicts among single-purpose watershed plans, such as a water supply plan or a flood-control plan in a watershed, and between single-purpose ones and their relevant integrated watershed plan. For an integrated watershed plan, it often includes various single-purpose watershed plans and it provides a framework for those single-purpose ones.

2.2.2 Environmental Implications in Watershed Development

Watershed developments often involve various engineering projects, such as those for hydropower, flood control, water supplies, navigation, and irrigation and so on. On one hand, construction, operation and removal of large-scale water conservancy projects often lead to wide influences on water environments and ecosystems. On the other hand, batches of small-scale projects, such as small hydropower stations, may also cause irreversible and long-term environmental consequences due to their temporal and spatial cumulativity.

Comparing with other kinds of engineering projects, the environmental consequences caused by the water-related ones exhibit distinctive features, which are characterized by wide spread, large scales, large affected population, complexity and multiplicity. Some of them are even long-term and irreversible. The influences of individual engineering project may be often limited, but the cumulative ones in watershed cascade developments should never be underestimated.

Due to difference in the engineering projects themselves, different scales and locations, they usually have different environmental implications. Moreover, the engineering projects themselves usually let few environmental pollutants, but mainly influence water quality and regional ecosystems by altering hydro-morphological conditions.

Besides the environmental changes caused by water-dependent projects, other social and economic activities also influence the watershed environments and ecosystems. Theoretically, their environmental implications should also be considered, especially when conducting CEAs. That increases the difficulties and uncertainties in CEAs. Therefore, grounding on practicability, recent CEA will focus on the environmental potentials of watershed developments, with little consideration of other actions.

(1) Environmental Implications of Individual Project

Different locations of the engineering projects, for example, the reservoir area, construction areas of dams, and the lower reaches of dams, may lead to different characteristics in their environmental consequences. As a rule, in the reservoir areas, the main environmental receptors include water temperature, hydrodynamic condition, water quality, environmental geology, water and soil loss, landscapes, ecosystems and biodiversity, which are mostly attributable to reservoir inundation and changes of hydrological regime in the reservoir. At dam sites, the ecological integrity is often severely destroyed, where uncovered rocks and buildings are extensive. In the lower reaches of the dam, long-term influences are common, mainly induced by the changes of hydrological regime; the main environmental receptors include hydrology, river regime (the changing conditions of river beds and other features, such as systems of sandbars), water temperature, water quality, aquatic creatures, wetlands, and ecosystems at the estuary.

Previous researches on environmental effects of water-dependent projects focused on the stages of construction and operation, but seldom analyzed the plan's role in affecting the environmental consequences of watershed developments. In fact, the plan may influence the types, scales, locations and mitigation measures of the environmental implications by planning the involved projects and their scales and locations. Once they are determined, their consequences are almost inevitable or costly for being avoided and mitigated. That's why PEIA should be conducted, as well as project-EIAs. After the plan has been determined, both subsequent construction and operation of the planned projects may bring various environmental consequences. In a short period, the effects of individual project, especially a small-scaled one, are not palpable. However, the space-crowding results of numerous ones and the time-crowding results of an individual, especially a large-scaled one, and all projects in the watershed may cause inestimable environmental damages. Generally, the direct environmental potentials of watershed developments mainly include variations in landscapes, changes in hydrological regime, worsening water quality and degraded ecosystems. Thus decreasing biodiversity and changes in local climates are the main indirect environmental consequences. The particulars of potential environmental consequences in different periods, constructing and operating periods, which are often fundamentally established in the plan, are to be analyzed for understanding their continuous effects in the following sub-sections. Project-EIAs are preferred for identifying the environmental potentials of individual project during construction and operation, but the continuous actions and spatial accumulation of all involved projects need to be analyzed with the support of watershed-PEIAs.

1) Constructing Period

Construction of the water-related projects involved in watershed developments mainly leads to the following environmental impacts: ecological damage in the terrestrial-aquatic interfaces, water and soil loss, noise, solid wastes and particle pollution in the air. They are mainly associated with builders' everyday life, facilities' activities, excavation for construction, wastes, temporary occupation of lands.

Large amounts of earth and rocks are necessary for building the dams. Thus severe disturbance and demolishment occur in the surfaces of the involved borrow pits, which almost completely destroy the surface vegetation. For example, in riparian zones, wetlands and other riparian ecosystems may be destroyed when building or reinforcing the dams, which are necessary for water conservancy and hydropower projects. Thus, the habitats of the associated creatures and plants may be disturbed, and they, even rare species, may have to migrate or even be killed out.

In addition, as mentioned above, earth borrow pits, intercepting ditches, drainage ditches, land reclamation of immigrants and land occupation for construction may disturb the surfaces and vegetation. Thus, water and soil loss is easily induced or worsened if no effective measures for renewing and protecting the disturbed land surfaces.

Thirdly, construction of those dams and others also produce wastes. The daily disposal of the builders, especially in the dry period, enters into the water body and deteriorates the water quality. Moreover, solid wastes during the construction, such as aggregates, lump limes, concrete blocks and powdery building materials, also have negative environmental potentials. They often pollute the soils or rivers, if no duly and effective clearance.

Fourthly, noise produced by the vehicles and machines is unavoidable, which not only influences the production and life, but also the health of the local inhabitants, especially the health of those operators. Moreover, noise and the activities of the machines and builders also drive the fishes and other animals from their habitats.

Finally, flying dust produced by excavation and transportation is one of main atmospheric pollution sources in the construction field. Emissions from the machines are also likely to influence the air quality. The increased floating dusts and deleterious ingredients may damage the nearby crops, as well as the living conditions of the inhabitants.

Most water conservancy and hydropower projects may bring the above consequences, more or less, especially those large-scale ones. Parts of them could be mitigated by man-made efforts. In addition, parts of them, such as noise, flying dust and temporary land-occupation, are temporary. As for other environmental effects, they could also be recovered if timely and vigorous restoration measures are available. However, permanent land-occupation and destroyed riparian ecosystems, which will be analyzed as a part of CEA, are usually hard to be repaired at once after finishing construction.

2) Operating Period

When operating these facilities, the environmental potentials are complex, which are to be briefly discussed mainly from the following aspects: local climate, hydrological regime, ecosystems, especially aquatic creatures, and risks. Subsequently, their cumulative consequences will be discussed in more detail.

Building reservoirs and irrigation facilities means to change the lands to water bodies or wetlands. Thus local surface airs tend to become more humid than its original ones, which may influence its precipitation, air temperature and winds.

Secondly, operation of them surely changes the hydrological regimes, especially in the reservoir areas and their lower reaches. In reservoir areas, when they began water storage, the water levels and water depths must increase; the water surface gradient must become smaller and the flow velocity tends to decrease. Similarly, in the lower reaches of the operating facilities, changes in hydrological regime often lead to decreased dynamics because large amount of water is stored in the reservoirs and *zero flow* emergences even in some river courses. Along with that, water quality tends to be worsened and even *eutrophication* comes forth in some reservoirs and river courses with fixed total pollutants and the aquatic habitats tend to be destroyed with the worsening water quality.

Thirdly, the dams block the natural river flows and change the natural ways of transporting matters and energies. In the upper reaches, the riverbeds are increasingly uplifted by the alluvial sediments, because the suspending matters tend to deposit in the near vicinity of the dams and in the reservoir tail without enough flow velocity and energy. These sediments are hard to be removed, even after the dams are dismantled. The sedimentation in the reservoir and the upper reaches also implies decreasing the sediments into the lower reaches. Thus the estuaries may shrink. At the same time, the food sources may decrease with the decreasing input of terrestrial detritus.

Fourthly, as mentioned above, the changes in the hydrological regime and the physico-chemical properties in the reservoir areas and backwater areas must not be neglected, especially their influences on sensitive aquatic creatures. The forced variances in aquatic habitats may lead to diminishing population size, injuring the population distribution, and even the extinction of some species.

The fishes and other aquatic creatures, especially the migratory fishes and macro-invertebrates sensitive to aquatic environments, may be highly endangered or confronted with extinction, due to interdicted migratory passages and distorted hydrological regime. Moreover, the habitats of native species and some spawning sites of fishes may disappear due to alteration of the hydrological regime, especially in lower reaches. However, those species adapting themselves to static water ambient may increase slowly. Further, the ecological integrity may be destroyed due to the land-cover changes caused by the engineering projects, which are also likely to damage terrestrial and aquatic ecosystems.

The environmental implications in the above periods could also be categorized into those associated with *hydro-morphological regime*, *lake effect (water quality)*, and *aquatic ecosystems*. In general, each individual project may lead to part of the above environmental potentials more or less. Even when it only has limited functions of adjusting and storing water, its environmental implications should be considered based on the cumulative effects of the associated ones.

1) Hydro-morphological Regime

The changes in this dimension mainly include variation in flow regime, river continuity and morphological conditions. Changes in flow regime are the most direct influences of watershed developments, which may lead to seasonal cutoff of rivers, or dehydrated river sections, or changes in characteristics of floods, or increases of sediments in part river sections, or strengthening erosion in estuaries, or intrusion of salt water, or lingering pollutants. Accordingly, water quality tends to vary with the above changes. Generally, periodic operation of hydropower stations lead to periodic undulations of stream flows in the lower reaches.

Moreover, occurrence of inner or outer barriers may impact migration of aquatic organisms. Dams and road crossings are the most familiar artificial barriers altering aquatic habitats and disturbing river continuity. Further, changes in river morphology are mainly characterized by alterations in river width, depths, and river bed, which are attributable to the variation in flow and sediment concentration along the river canal.

2) Lake Effect

As for lack effects, they include eutrophication, siltation, and local climates of reservoir areas. Increases of nutrients in reservoirs may be attributable to vegetation and soil organic matters in inundation areas, manures from the upper reaches, nutrients from aquaculture industry and domestic sewerage from tourism in reservoir areas. The long-period accumulation of those nutrients could explain the occurrence of eutrophication and deterioration of water quality, and project-CEA is preferred for analyzing it. Practically, during the watershed-PEIA process, only for large-scale reservoirs, CEA about eutrophication is suggested to be conducted. Silts tend to deposit in reservoirs due to the weakened dynamics. Reservoir silting speed is one of the main factors affecting the life-span of a reservoir. The changes of local climates are generally characterized by decreases of temperature difference between day and night, being cooler in summer and being warmer in winter, increases of humidity and water mists.

3) Aquatic Ecosystems

Variation in hydrology and 'Lake effect', then, affect the aquatic ecosystems in reservoirs and lower reaches. On one hand, migratory fishes and other aquatic creatures adapting to running water decrease or even die out. On the other hand, planktons and fishes suitable for static ambient or tranquil-flow water areas increase in reservoirs and lower reaches. Thus the dominant species and species abundance vary with the changing ecological structure.

(2) Cumulative Environmental Implications of Watershed Developments

Watershed developments are usually multi-objective, which need to consider the comprehensive benefits, including hydropower, flood control, water supplies, navigation, and irrigation and so on. The associated engineering projects have to be developed for promoting economic and social developments in the watershed. However, they often have environmental implications, especially those negative, extensive and cumulative ones, which are often multi-tiered, multi-faceted, interlaced and irreversible. They are the time-and-space-crowding results of both construction and operation of water-dependent projects. CEA in the PEIA process is necessary for avoiding and mitigating the great damages of negative cumulative ones.

Appropriate CEA methods are necessary for watershed-PEIAs, which have attracted increasing concerns despite the current difficulties. Based on the CEA details in Section 2.1.3, three kinds of criteria are used for categorizing cumulative consequences: *source*, *process* and *effect* (Fig. 2.4). Here, Fig. 2.6 briefly introduces the typical cumulative effects of watershed developments and the details are provided in the following sub-sections.

1) Variances of Watershed Landscapes

Variation in landscape is the visual exhibition of watershed developments, which is mainly characterized by *increasing landscape fragmentation* and *damaged landscape functions*. In some watersheds, such as the Jiulong River, the natural integrity of the watersheds has been destroyed and torn into pieces due to the disturbances of excessive man-made water-related projects. On one hand, construction of water-dependent projects and other associated facilities directly changes landscape structures. On the other hand, alterations of habitats and wetlands are marked by variation in landscapes. Therefore, landscape indicators could be used for evaluating the changes in habitats and wetlands.

2) Changes in hydro-morphological regime

When large amounts of reservoirs begin to operate along a river, even their scales being insignificant, the discharges into the lower reaches decrease. The *hydrological regime*, including water levels, flows, sediment transport and flow velocity, may have great changes.

Generally, in reservoirs and lower reaches, flow velocities and stream flows decrease. Correspondingly, hydrological dynamics become slow due to time-crowding results of repetitious water storage and blockage. In addition, excessively dense dams and reservoirs are one main reason of increasing *dry-up river courses*, for example, those in the Yellow River. Therefore, the requirement of the minimum discharge for each engineering project is advisable.

Long-term low flow velocity is one of the main factors leading to *reservoir sedimentation*. Accordingly, the river-bed-making capacity in lower reaches is badly influenced, which is the incremental, time-crowding and space-crowding outputs of its upper engineering projects. Thus the shrinkage of estuaries and fish spawning sites exists in many rivers, such as the Major Seven Rivers of China, if no effective management is undertaken for all the involved engineering projects.

Thus, blockage of dams and occurrence of dry-up river sections often lead to the damages on river continuity. Moreover, morphological variation in river channels and watershed surfaces are inevitable. The indicators for assessing their changes will be expounded in Chapter 6.

3) Worsening Water Quality

In reservoirs and part river courses, *water quality* worsens and even *eutrophication* emerges as time-crowding results of repetitious water storage. These consequences have intimate correlations with the changes in hydrology and the above environmental effects.

As discussed above, blockage of reservoirs changes the hydrological regime in reservoirs and lower reaches. Correspondingly, self-purification capability, self-degradability and environmental capacity decrease chronically in the static ambient in reservoirs and part of the lower reaches, especially the dry-up river courses, under the influences of repetitive blockage of dams and storage of reservoirs, especially in dry periods. The presence and operation of numerous reservoirs and other associated facilities usually aggrandize the environmental effects.

4) Damaged Ecosystems and Decreasing Biodiversity

If numerous barriers blocking the water flow, series of environmental issues rush: changes in hydrological regime and water quality. Blockage of migratory passages, shrinkage of fish feeding, spawning, and wintering grounds, and shrinkage of estuaries occur as responses to the distortion in flow regime, river regime and water quality. Accordingly, distortions in ecosystem and biodiversity are characterized by *shrinkage or even disappearance of natural habitats*, *decreasing wetlands*, *decreasing migratory fishes and even extinction*, and *decreasing biodiversity*.

Individual engineering project also has such environmental potentials, but the cumulative consequences of numerous projects are more devastating and even irreversible, and more uncertain. They have more wide ranges and more complex relationships, which indicate more difficulties in assessing them.

Numerous dams blocking the passages of migratory fishes, shrinking spawning sites, the static water ambient, decreasing river flows in lower reaches, shrinkage of estuaries, and worsening water quality combine to produce the above ecological problems, which have been defined above. In addition, less nutrients from terrestrial input restrict the developments of aquatic creatures. Growth and propagation of some aquatic creatures are damaged and even some species disappear. Of course, some species propagate speedily, especially anaerobes and those adapting themselves to the static ambient of the reservoirs. Thus, invasive and new species emerge. The propagation of such creatures tends to worsen the bad water quality further.

In fact, in most cases, cumulative consequences could not be attributable to one single mechanism, which may be the combination of the incremental process and the interactive process. In addition, various consequences may have intricate relationships. For example, both the incremental effects of all reservoirs in the watersheds blocking the migratory passage and the shrinkage of fish spawning sites could explain the decreasing migratory fishes and even the extinction of some fish species. The blockage of the migratory passages and the shrinking spawning sites are additive. Another example is about the heave metal pollutants in reservoirs. The static ambient of reservoirs make the heavy metals easily to be cumulated in sediments. On one hand, these pollutants are absorbed by suspending particulates and cumulate in the sediment. On the other hand, their concentrations increase by bio-magnification across food chain. Once the cumulated metal pollutants enter the human body, serious harms to the health occur. Moreover, some consequences may be the linkage of time-crowding and space-crowding.

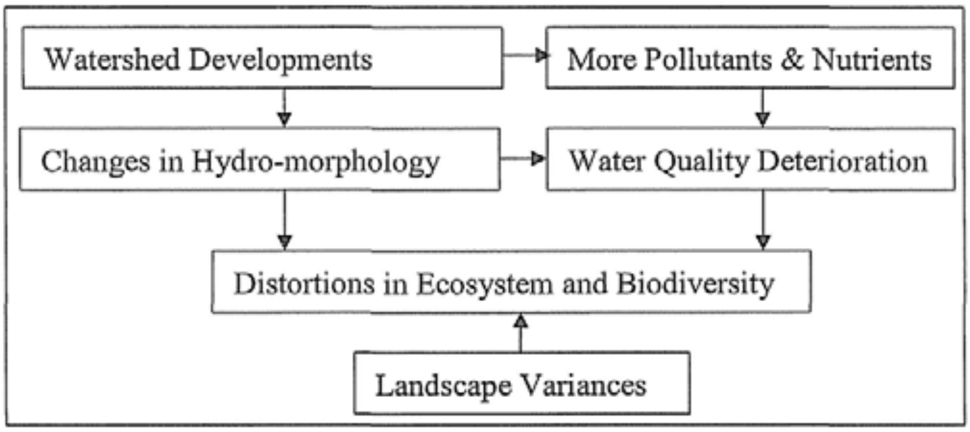

Fig. 2.6 Cumulative Environmental Implications in Watershed Developments

The above four aspects of cumulative implications in watershed developments are also interactive (Fig. 2.6). Altered hydrological regime is the most direct effect of watershed developments. Accordingly, natural river regime is disturbed and water quality deteriorates, which is mainly attributable to the changes in hydrological regime if no more pollutants and nutrients. Changes in hydro-morphological regime and water quality combine to account for distortions in ecosystems and biodiversity. Variances in 'landscape' could be adopted for visual presentation of the distortions in other three facets, especially for visually explaining ecological distortions, such as those in riparian zones, habitats and wetlands.

2.3 Watershed-SEAs: Theories and Practices

2.3.1 Necessity and Rationality of SEA in WM

Despite the need for much improvement in the procedures, methods, legislations and others, it is unassailable that SEA has significant potential to generate environmentally sound decisions about watershed management. Besides the general benefits, SEA for watershed management, watershed being a basic management unit, has specific advantages to management of the natural resources, especially water resources, and the ecological systems.

Although the overriding objective of watershed management is also to achieve sustainable development, similar to that of SEA, most watershed managers focus on achieving multi-objective purposes, especially allocation of water resources and mitigation of water-centered hazards, rather than mainstreaming environmental protection. Integration of environmental policies into decision-making is the overarching concern of SEA, but not the core of watershed management. Today's economy-led attitudes of most watershed managers, government agencies and involved stakeholders often lead to ignorance of watershed environments and ecosystems. Moreover, collective environmental consequences of various activities in a watershed often fail to be integrated, which are promising to be addressed by effective and systematic SEA processes.

Therefore, on one hand, watershed-based management should be conducted for considering the integration of hydrological and ecological functions. On the other hand, SEA should also be integrated into each stage of the whole watershed management process. Watershed-based planning process alone often can't fully and profoundly integrate environmental policies, with only superficial introductions of environmental issues and even without any mention of them. The application of SEA in watershed management actions pushes the agencies and the stakeholders to set mind on environmental objectives during decision-making, especially helps to conduct CEA of watershed-based developments, as an integral part of SEA.

Furthermore, local changes in water quality and water quantity may lead to alterations across the whole watershed, even including the hydrological functions and environmental functions, as well as water resources, due to the flows of surface and ground water. Local changes in water resources may cause watershed-wide, even irreversible, effects. Timely integration of SEA into each stage of the watershed planning process could prevent negative environmental issues as early as possible, so as to avoid or reduce the time- and cost-losses caused by the potential environment-unfriendly facilities and actions before their occurrence. That is to say that all negative environmental potentials hope to be nipped in the bud if , with the interference of effective SEA instruments.

Thirdly, both watershed plans and SEAs have potentials to change the societal values and priorities and even the communities' life-styles, although social change tends to experience a gradual and slow process. Integration of SEA into watershed planning process tends to involve various sectors, diverse disciplines and a large variety of stakeholders, which helps to gradually raise public awareness, together with increasing the prominence of water issues and concerns on PEIA in media. In addition, watershed plans should reflect multi-values of different participants and stakeholders, so its associated SEA should also need consider the tradeoffs between different groups of interests and try to achieve their coordination. Thus integrated approach will be increasingly adopted and effectively applied in watershed management. In fact, the ideas of environmental crisis, active participation in the decision-making process, and sustainable development are being penetrated into the wider and wider public, from developed countries to developing countries, from the urban area to the countryside, from the research agencies to the government agencies and then to the general communities and individuals. An increasing number of stakeholders certainly will strive for taking their various rights in watershed planning processes, especially in developed nations or developed regions in developing countries, with more and more SEA efforts in water sector.

Finally, it is also necessary to apply SEA during the decision-making process of water-related policies and legislations. Often, a batch of projects may be products of water-related policies, as well as those associated with watershed management plans. For example, the prevalence of small hydropower projects along the rivers in Southwest China has direct relationships with Incentive Policy for SHP (Small Hydropower Projects). The ecological crisis or disasters in western and south-western watersheds of China has more or less relationships with Incentive Policy for SHP, Water Conservancy Industrial Policy and Water Resources Policy and so on.

In China, the ongoing nationwide revision of integrated watershed plans certainly will bring many projects and conflicts between sectors and groups of various interests. Those watershed plans under revision, together with Ordinance of PEIA, provide opportunities for applying SEA in China's water sector. The nationwide promotion of watershed-PEIAs requires the wider public involvement, which certainly will raise public awareness of environmental protection and maintenance of rights. However, few researches and no detailed brochures are applicable for practical guidelines. With this in mind, a SEA framework is required for exactly guiding watershed managers on how to integrate environmental considerations into watershed management processes in China. Of particular note, it should focus on assessment of the whole watershed planning process and each of the alternatives, as well as assessment of the final documents.

2.3.2 Legislation Associated With SEA for Watershed Management

When compared with other sectors, especially transport and land use, very few studies about SEA have been performed in water sector. Early in 1990s, SEA has been proposed as a powerful tool for watershed management (Barrow, 1998; Heathcote, 1998). However, few cases of applying SEA to watershed management are available, besides several in developing countries, such as the Integrated Citarum Water Resources Management Program, Indonesia, as well as those associated with UNECE Protocol on SEA and the SEA Directive of EU; watershed management is still not one key arena of SEA application.

(1) UNECE-SEA Protocol

According to Art 3 of the Directive, plans and programs for water management are in the obligatory scope of applying SEA. Moreover, plans and programs associated with the following projects: 'dams, inter-basin transfers, wastewater treatment plants, irrigation schemes, and groundwater abstractions' are also subject to SEA.

(2) EU-SEA Directive

WFD was adopted in 2000 and required to be converted into national legislations of each member state in 2003. In addition, de jure, all EU member states are obligated to transpose the EU SEA Directive into their own legislations, considering 'appropriate capacity building' before July 21st, 2004 (Therivel, 2006). However, de facto, by July 2005, only 15 member states have ratified it (Therivel, 2006). The linkage of SEA Directive and Water Framework Directive is a good example of integrating SEA into watershed management. Each member state of EU is obligatory to establish watershed districts and produce watershed management plans, based on the key requirements of WFD. Preparation of WFD's required watershed plans and others associated with water management falls within the remit of the SEA Directive; coordinated and integrated procedures should be developed for meeting the common requirements of the two directives (Carter, 2006). Further, SEA for land planning under SEA Directive also has potential benefits for water management.

(3) PRC -The 2003 EIA Law and Ordinance for Planning EIA

The 2003 EIA Law requires the integration of SEA into watershed planning processes, as well as water conservancy and hydropower planning processes. Overlaps between watershed plans and regional water conservancy plans, between watershed plans and regional hydropower plans are potential. Crucially, Ordinance for PEIA has broken the cocoon into a butterfly after 3-year efforts, which signals a new landmark for managing natural resources and ecological systems, including water resources and watershed system, in China, despite it being much coarser than the first draft. Similar to the linkage of WFM and SEA Directive, coordinated SEA procedures comprehensively considering watershed plans, regional plans, and specific plans 'should be developed to avoid unnecessary duplication of effort'

(Carter, 2006).

With The 2003 EIA Law as a backdrop and a milestone, Ordinance for PEIA has been enacted through 3-year efforts from the drafting work, which is covered in detail in Chapter 4. Although this ordinance provides general guidelines for PEIA in China, it is a great pity that some beneficial details and some operable provisions (e.g. public participation and public interest litigation) were deleted. Moreover, The 2003 EIA Law and Ordinance for PEIA provide certain political support in some degree, but SEA for watershed management is still hampered by resistances from some institutions such as the water management institutions and limited societal supports, which will be discussed in greater depth in Chapter 4. Of particular note, environmental assessment practices have been conducted earlier than The 2003 EIA Law, based on the provisions of Regulation for EIA of River Basin planning (SL45-92).

2.3.3 SEA Cases in Watershed Management Processes across the World

Although SEA in land-use planning and the transport sector has been fruitful, SEA practices in watershed processes are still in a relatively early stage. On one hand, watershed management is much involved: multi-sectors, multi-values, multi-disciplines, and even multi-laterals. On the other hand, SEA implementation is also not straightforward, needing the trade-offs between groups with various interests and values and the coordination of multi-disciplines. With this regard, their integration needs more efforts for both practices and researches.

Among those efforts, linkage of SEA Directive and WFD is a milestone both in Europe and in the whole world. Besides linkage in EU, such cases have come into bloom in many other regions or nations in recent years, despite still being in early stage.

(1) SEA for Watershed Management in EU

With the linkage of SEA Directive and WFD, EU states have taken initiatives to conduct SEA for watershed management. Such cases are available in several countries, exemplified by online information in UK, Spain, Denmark, and Ireland and so on. Their schedules about the planning and SEA processes mainly follow the main stages of WFD in the first cycle, with little alteration. The involved procedures, environmental topics and methods are provided by SEA Directive, which underwent minor amendments for adaptability to each case. Comparatively, the EU member states are systematically conducting a series of SEA actions for watershed plans, which are deserved for reference.

According to SEA Directive, 'environmental baseline and problems, links to other plans, programs and environmental objectives, the likely effects of the plan/program and relevant alternatives, and proposals for mitigation measures and monitoring' should be covered in the required environmental report (Therivel & Walsh, 2006). Moreover, public participation and monitoring are also prescribed by the aforementioned Directive. Finally, the consideration of climate change is also a requirement of both the SEA Directive and the WFD.

Few available technical reports and associated researches frustrate the deeper understanding of the assessment methods, and only some superficial notes could be summarized. Firstly, it is clear that part of EU member states have commenced on watershed-based PEIA efforts, complying with the SEA Directive and WFD as precursors. Secondly, the following aspects are deserved to be referred to: review of relevant policies and plans every six years, even with an interim review after 3 years (e.g. the case in Neagh Bann IRBD), and the consultations starting from the scoping stage.

However, EU member states still exhibit some unsatisfactory aspects. The strict time line of RBMPs (River Basin Management Plans) in EU member states don't allow of the necessary time-consuming analyses as they should have been. Thus, the ambitions for improving water environment up to 2021 or 2027 is an arbitrary deadline extension of the 'good status' objective of WFD by 2015 (Hontelez, 2009). In addition, only parts of environmental receptors were quantifiable, mainly due to the limited data availability, the intrinsic and technical uncertainties and the required details of PEIA. Thirdly, poor boundaries and administrative overlap may also be the main difficulties of watershed management and its SEA in UK and other states; the hierarchical processes from EU to lower-level scales even than member states lead to the extreme complication 'due to the interaction of many different stakeholders and the integration of many different issues' (Blackstock, 2007). Fourthly, transparent watershed management remains limited in EU states (Hontelez, 2009), although early consultations have been reported in some watershed planning cases and their associated SEA process. Finally, 'Authorities seem to stick to a minimalist and legalistic approach in implementing the WFD, instead of focusing on tangible and meaningful results for citizens and their environment' (Hontelez, 2009). That also holds true when environmental authorities and watershed planning agencies conduct watershed-PEIAs for meeting *The 2003 EIA Law* in China's watershed management and SEA efforts.

(2) SEA for Watershed Management in USA

Watershed management has carried weight in USA early in the 20th century, but it is still faced with many obstacles. The experience from Tennessee Valley Authority (TVA) has been referenced by many nations and researched by many scholars. According to *New Strategies for America's Watersheds*, 1999, watershed management agencies tallying with the coverage of the concerned issues tend to be more effective. Therefore, multi-tiered watershed management system is desired for tallying with watersheds of various scales. For issues that could be solved in a small-scale watershed, higher-level watershed management agencies are not necessary, which are suitable for relatively extensive issues, comprehensively considering the interests of various parts of one watershed, as well as those of various groups.

As known to all, National Environmental Policy Act (NEPA) has comprised higher-level EIAs, other than Project-level EIA in its early version. However, such cases and researches for watershed management are not prominent, compared with those for land use and transport. Only in recent years, the online documents and articles about several cases are available for review and consultation.

Although no details about watershed-PEIA cases in USA are available, several significant hints could be obtained from the limited online data and documents. Firstly, the recent SEA reports are open to the public for consultation and review. Secondly, several alternatives are considered, often including a 'no action plan'. Thirdly, the individuals and agencies involved in watershed plans and watershed-PEIAs are introduced in EIS (environmental impact statement), so that clear responsibilities and obligations help to improve the EIS' quality and the effective implementation.

1) PEIA for Tobesofkee Creek Watershed, Georgia (NRCS, 2003)

This plan was initiated in 2002 for protecting and improving water quality in Tobesofkee Watershed. The technical procedures are mainly as follows (Fig. 2.7), which shows that the public was involved throughout the whole planning process. Public meeting and questionnaire were the main ways of public involvement. The involved participants and consultants include an Interdisciplinary Planning Team, a Technical Advisory Group, and stakeholders. In this case, alternative formulation and selection were the core of the watershed planning process and the associated EIA process, including informal indicator survey, development of evaluation units, revision of all possible practices in the National Conservation Practice Handbook, selection of locally acceptable practices and combining them into 5 alternative plans; the AWQWA model (Agricultural Water Quality Watershed Assessment) was adopted for identifying existing cause-effect relationships between Evaluation Units and water quality within the area under consideration and for providing a benchmark condition of assessing alternatives and selecting one. As for the EIS writing, the final EIA statement for watershed plan was established, having integrated inter-agency review comments into it based on a drafted version and a final draft version. Notable in this case is the fact that its EIA process and its planning process were integrated and close-knit. However, cumulative effects are not addressed in detail in the final statement.

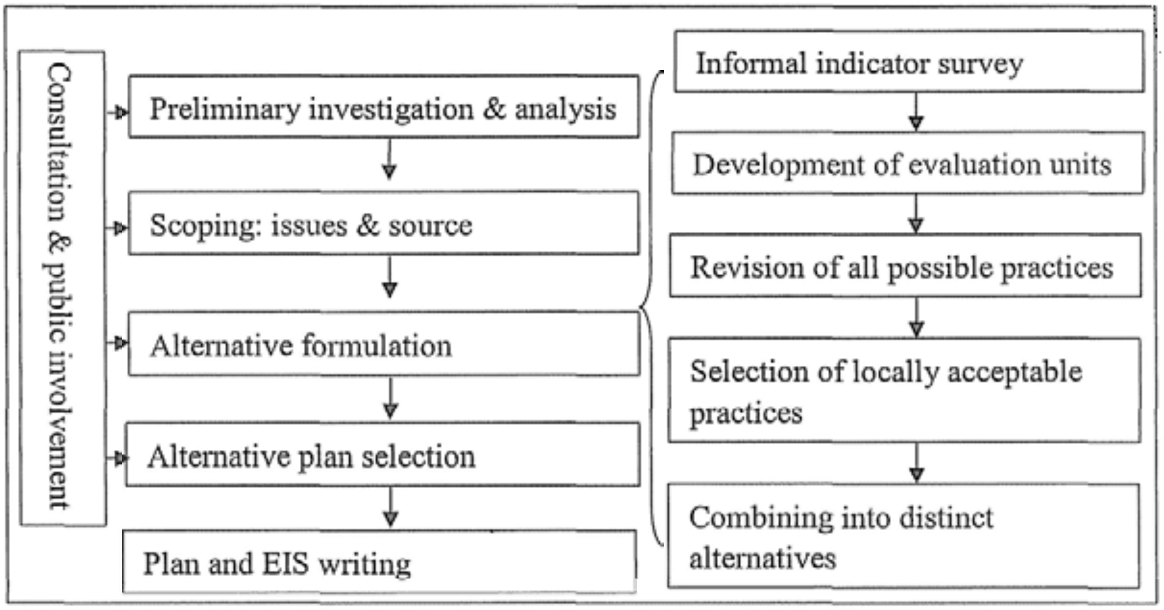

Fig. 2.7 Main EIA Procedures of Tobesofkee Creek Watershed Plan

2) Cases administered by Dillon Field Office, 2009

EAs were respectively conducted in the following watersheds in 2009: Blacktail, South Tobacco Roots, Beaverhead West, Red Rock/Lima, East Bench, Rochester Basin and North Tobacco Root, East Pioneer, which permitted 30 days for public review and detailed EA statements are online (www.blm.gov/mt/st/en/fo/dillon_field_office.html, accessed by 2009/10/09), with monitoring arrangements. Their EIS reports generally include five sections: purpose of and need for the proposed action; alternatives; affected environment; environmental consequences; preparers, persons and agencies consulted. Most importantly, cumulative impacts of each alternative within the watershed under study were considered when assessing environmental consequences of the proposed plans. Moreover, various actions were involved in the past, the present and the future. The temporal boundaries extended from the late 1800s to the future. As for the spatial boundaries, the whole watershed under study and its continuous area were involved when assessing the cumulative consequences. However they were mainly disclosed qualitatively in a descriptive way, due to the difficulty caused by great uncertainty, especially in the future and the immature techniques.

USA has made great efforts for both SEA and watershed management as a pioneer, and increasing online cases are available, but few researches associated with SEA specific to watershed management are available. Although Heathcote (2009) has analyzed the general EIA methodologies in the two editions of 'integrated watershed management: principles and practices', but they are discussed isolated from watershed management and no specific details to SEA for watershed management are mentioned. Moreover, EAs are also touched in few watershed documents.

(3) SEA for Watershed Management in Asia

Besides China, Indonesia and India also have initiated such practices. They are respectively under the support of ADB (Asian Development Bank) and the World Bank. As for China, as well as its own efforts for SEA initiatives in watershed across China, the World Bank, ADB and EU have funded some projects for managing and improving environments and ecosystems in several watersheds.

2.3.4 Researches about SEA for Watershed Management

Although the articles about SEA theories exist in the journals across the world, few specific to watershed management are available (Grayson, 1995; Heathcote,1998; Hedo, 1999; Carter, 2006; Heathcote, 2009). Even today, when, with the linkage of SEA Directive and WFD, more and more nations have applied SEA to their watershed planning processes, there is not a title of evidence that researches have received increasing attention. Obviously, the associated researches lag behind such practices.

The only few journal articles respectively focus on the following aspects: linking SEA Directive and WFD, application of AEAM (Adaptive Environmental Assessment and Management) in integrated catchment management, case analysis in Spanish and other EU member states, and the general EIA methods applicable to watershed-PEIAs. Although the methods generally adopted in SEA cases of other sectors could be adjusted for being used in watershed management, the methods specific to the sector and the decision-making contexts need to be designed. Moreover, the selection of indicators should be 'a direct reflection of' 'the ecological characteristics' of the planned region, rather than 'copy' the indictor system applicable in other similar cases without any revision (Hedo, 1999). It is a great pity that associated researches specific to watershed-PEIAs are almost blank, which is an imperious task.

In China, similar oddities exist. For the study in question, watershed-PEIAs, few literatures exist and few theoretical references can be used for promoting the prevalent watershed-PEIA practices. Approximately, 30 journal articles and some literature of other types, which are specific to watershed-PEIAs, are obtained. Among those literatures, 18 articles referred to SEA for integrated watershed management plans (Chen, 1985; Xu, 1985; Xiang,1986; Xiang, 1988; Yao, 1989; Zhu, 1992; Yu, 1997; Luo, 2005; Zhou, 2007; Zhu, 2007; Deng, 2007; Zou, 2007; Sun, 2007; Sun, 2007; Cai, 2008; Fan, 2008; Liu, 2008; Wang, 2009). In addition, most of the left ones focus on cascade hydropower developments. Several papers about watershed-PEIAs and their timely open progress reports in 1980s proved early concerns on EIA specific to watershed management (Huang, 1985; Chen, 1985; Xu, 1985; Xiang, 1988; Yao, 1989; Zhu, 1992). In 1990s, few such literatures are available, besides the two articles respectively mentioning the cases in Zhejiang Province and in the Yangtze River Basin (Yu, 1997; Zou, 2001). In the recent decade, especially after The 2003 EIA Law, the increasing literature on watershed-PEIAs show the growing concerns on them, which include conference papers and news in brief, as well as journal articles.

Those literatures focus on the necessity of watershed-PEIAs (Xu, 1985; Zhu, 1992; Luo, 2005; Zhu, 2007), the qualitative and general description of the backgrounds and the EIA outputs by case analysis (Zhou, 2007; Cai, 2008), EA indices (Zou, 2007; Cai, 2008; Fan, 2008), EIA procedures and the contents of the EA reports (Yao, 1989; Zhu, 1992; Luo, 2005; Liu, 2008). However, no literature has systematically addressed any theme associated with watershed-PEIAs, besides few index systems. For example, 'CEA', one of the key themes associated with SEA, has been mentioned only three times in the above articles and even the three exceptional ones didn't try to go deep into it. In addition, there's no any evidence that context-specific methods have been developed. The actors in this domain tend to copy the procedures and methodologies adopted in PEIAs of other sectors. Moreover, two of the above literatures are named respectively by 'The EIA Practices for Watershed Plans in Zhejiang Province' and 'Preliminary Research about Integrated Watershed Plans in Fujian Province', which shows the current water resources management system in China, characterized by the concurrence of watershed management and administrative management. The conflicts between watershed agencies and administrative agencies may be one of the main barriers, limiting successful EIA for watershed management. However, the current water resources management system, as one element of decision-making contexts, has not been recognized in most literatures.

Of particular note, some EIA reports related to watershed plans, together with their schedules and progress reports, were published in journals in late 1980s and early 1990s (Chen, 1985; Huang, 1985; Xiang, 1988; Han, 1992; Zhu, 1992). However, now few documents related to watershed-PEIAs are available to researchers by perfectly justifiable ways; and even no EIA report was prepared for some watershed planning processes, but only one EIA chapter was included in the watershed plan report in most cases, although information openness and public participation are receiving increasing attention. In addition, literature analysis proved that relevant researches in the 2010s haven't show more progress than those in 1980s: the similar focus on necessity and no standard guidelines and procedures in both periods. Therefore, this study aims to build a framework with an index system, considering contexts specific to watershed management and national political system, as well as the scale and nature of the receiving watershed and the proposal in question.

This status shows the poor researches about watershed-PEIAs, particularly from 1992 to *The 2003 EIA Law*, despite the increasing concerns on such cases in recent years. Insufficient efforts for SEA researches and theories are attributable to the crazy careerism, trying to seek economic profitability by carrying on EIA tasks. EIA actors take lots of time to strive for EIA assignments. Then, batches of EIA reports are 'manufactured', most of which are approved beyond all doubt. However, implementation of them is seldom followed-up and examined. That's to say that their performance and effectiveness are questionable, which are to be analyzed in Chapter Five.

2.4 Summary

This chapter introduces theories about SEA, watershed management, and watershed-PEIAs, and, practices about watershed-PEIAs across the world. When analyzing the evolution of SEA theories, effectiveness, CEA, public participation, contexts and uncertainties were respectively discussed, providing theoretical foundations for designing the investigation questions, assessing effectiveness of the selected cases and developing a watershed-PEIA framework. As for watershed management, necessity of watershed management and watershed-PEIAs, environmental implications in watershed developments and especially cumulative environmental effects of watershed developments were systematically analyzed, which help to develop a context-specific watershed-PEIA system in Chapter 6.

Section 2.1 summarizes the conceptual evolution of the key themes associated with SEA researches. The main dimensions of the overall SEA effectiveness were introduced, based on the 'effectiveness triangle' (Sadler, 1996) and the 'Circular Effectiveness Cycle' (Baker, 2003). Based on the 'Overall Effectiveness Criteria', various components could be adopted for respectively evaluating 'substantial effectiveness', 'procedural effectiveness', 'trans-active effectiveness', 'normative effectiveness', 'incremental effectiveness' and 'contextual effectiveness'.

CEA, public participation, uncertainties and contexts are accountable for 'SEA effectiveness'. They are particularly presented here, providing the basic information for the study.

CEA has aroused increasing concerns, but more efforts still center on project-EIAs and only cursory consideration of SEA-linked CEA. Marginal consideration of CEA in SEA process is mainly attributable to technical complexity, uncertainties in development proposals, non-proficient actors, limited initiatives of the authorities, lack of legislative requirements, and time-and-cost-consuming problems. Technically, CEA is extremely complicated and lots of problems need to be overcome. In this study, methods appropriate for watershed-PEIAs will be briefly introduced in Chapter 6 and further researches are desirable in the near future.

Public participation, increasingly favored by the academics and practitioners, are confronted with various hindrances. Government authorities are often criticized for limited information openness. However, in fact, public understanding and participation awareness, which are often neglected, need to be considered, especially in developing countries. Therefore, appropriate participation modes need to be selected according to the characteristics of the proposal under study, and education levels and familiar disciplines of the participants. In virtue of the Vroom—Yetton model, the participatory way could be selected. As for participation awareness, it is not easy, which will be increasingly improved with social progress and economic developments, as well as wide publicity of environmental protection knowledge.

In addition, increasing academics have recognized that EA performance criteria are context-specific. Elements of contexts, macro and micro ones, are also the assessment components of SEA effectiveness. Therefore, legal and institutional arrangements, as macro contexts, will be particularly discussed in Chapter 4. As micro contexts, the roles of the important elements, based on document study, questionnaire and interviews and case analyses, will be reflected in Chapter 5 more or less.

Further, inevitable uncertainties, which should not be excuses of disregarding negative environmental potentials, could be categorized into objective or subjective uncertainty, uncertainty in process and in game theory. As for uncertainties in watershed-PEIAs, they mainly include four types: uncertainties of watershed plans, uncertainties of PEIA indicators, uncertainties of the involved engineering projects, and uncertainties of the discharges. All these uncertainties increase the complication and difficulty when undertaking watershed-PEIA and especially the CEA process.

Thus, this section provides the basic information for the ongoing study. In addition, the research gaps and the blind spots of SEA researches were also identified based on the above information. Among the measures for addressing uncertainties, multiple-scenario analysis is common in environmental management cases, as well as public participation and multi-party coordination.

Based on the information in Section 2.2, since the late 1980s, watershed approach has been adopted for managing water resources. Watershed has generally been accepted as the most appropriate unit of water management. However, current watershed management has to be up against many context-specific obstacles, as well as the common challenges of any collaborative planning process: inclusion of all stakeholders, integration of all involved issues, scales and processes, delivery of planning outcomes. The context-specific limitations will be discussed in Chapters 4 and 5.

Among various efforts on watershed management, more benefits exist in IWM than the single-purposed one. It could help consider cumulative consequences in a more comprehensive manner. At the same time, more uncertainties and more barriers exist than single-purpose ones, due to more involved actors and disciplines. The main difficulties include over-centralization and bureaucratization of decision-making authority, insufficient qualified staff of all types, inadequate IWM legislations and the inherent tendency of each group to maximize their own interests and minimize their efforts on the premise of meeting the laws and regulations in the smallest degree. With those in regard, the improvement of IWM institutions, the capacity building of watershed managers and the enforcement of watershed governance should receive more attention. In Chapter 6, a context-specific watershed management system will be developed for improving its management capacity.

As well as shedding light on the basic theories of watershed management, the concepts, the necessity of watershed management, especially IWM, the differences between watershed planning and regional planning, between watershed planning and specific/industry planning are clarified. In addition, the environmental potentials of watershed developments were also discussed in detail, particularly those cumulative ones. They are categorized into the cumulative changes in landscape, hydrology, water quality and ecosystems. Variation in landscape is the visual exhibition of watershed developments and the associated environmental changes. Therefore, landscape analyses could be used for assessing changes in other aspects, such as ecosystems. Further, the bulk of this chapter intends to highlight the recent progress in watershed-PEIAs in the subsequent subsection. Evaluation of them and associated indicators will be analyzed in Chapter 6.

In Section 2.3, necessity of SEA for watershed management is canvassed. Although the common overriding objective of watershed management and associated SEAs is achieving sustainable development, they have different focuses. Watershed plans alone, focusing on water resources allocation and water-associated hazards mitigation, can not fully integrate environmental potentials due to economic-led attitudes and social values. Therefore, it is necessary to conduct watershed-PEIA and SEA of water policies for avoiding or reducing the negative environmental consequences in the above four aspects and mainstreaming environmental protection.

Legally, EU-SEA Protocol, EU-SEA Directive and The 2003 EIA Law have prescribed the requirement of conducting watershed-PEIAs. Accordingly, watershed-PEIAs don't flourish until the 2000s, especially the linkage of WFD and SEA Directive.

As for associated researches, few journal articles indicate the insufficient efforts on them. The main reason for little concerns on researches is craze careerism, which drives them to only seek economic interests. Therefore, this study intends to provide preliminary information for future research efforts, as well as developing context-specific watershed-PEIA framework.

Chapter 3 Methodology and Framework

3.1 Research Framework

As shown in Section 1.3, the primary objective of this study is a context-specific watershed-PEIA (Plan-EIA, environmental impact assessment for plans) application framework, accompanied by an indicator system. For those achievements, the research framework is outlined schematically in Fig. 3.1, which includes four research stages and the main methods at each stage.

3.1.1 Stage 1。 – Literature Review: SEA, Watershed Management and Watershed-PEIAs

In this stage, literature review will be undertaken for analyzing the concepts and theoretical bases of SEA (strategic environmental assessment) and watershed management, examining the existing methodologies for addressing key SEA issues, providing the insight into the research progress, seeking the research gap, and identifying the research topic. The literature involves journal articles, documents and online information.

During the review process, terminology and theories associated with SEA and watershed management should be of interest, before introducing watershed-PEIAs, linkage of SEA and watershed management. Necessity, practices and researches of watershed-PEIAs, being as the study focus, will be illuminated at large.

Thus far, large quantity of literature review about SEA has been done in many researches. In this research, the review will be undertaken and illustrated according to the main SEA concerns and key SEA themes, which are respectively SEA effectiveness, CEA (cumulative effect assessment), public participation, contexts and uncertainties.

At this stage, SEA performance criteria, cumulative environmental implications in watershed developments and their CEA, and evolution of watershed-PEIAs will be paid particular attention to. Thus, this stage forms the basis for the ongoing studies.

3.1.2 Stage 2 – Collection of Cases and Documents about Watershed-PEIAs

For understanding the status of watershed-PEIAs, collection of associated cases and documents are necessary. However, low availability of water-related data is well-known; few watershed planning reports and associated PEIA reports are available. Fortunately, some cases have been listed for references in '*Analyses on EIA Cases*,' and '*Comments on SEA Cases*', edited by EPD, PRC. Besides the formal documents, online documents, news and circulars are also helpful for the study, as well as little information in research articles.

3.1.3 Stage 3 – Identifying the Status of Watershed-PEIAs in China

At present, Watershed-PEIA has caused growing interests. However, it is not easy to be acquainted with the Watershed-PEIA system, notably in developing countries, due to the low availability and even the absence of their relative documents. Therefore, besides the available documents and research articles, the outputs of questionnaires and interviews are significant for the research. The questionnaires and interviews will be developed for evaluating the performance of current watershed-PEIAs and identifying the main potential obstacles of watershed-PEIAs and the research priorities. The available cases will be used for evluating their effectiveness based on 'The Overall Effectiveness' and further explaining the main limitations in current SEA system for watershed management. Then, the current watershed-PEIA system in China, which will be presented in Chapter 6, could be summarized and introduced, including legislative, institutional, cultural, and technical dimensions.

Moreover, beneficial suggestions will be presented for improving the current watershed-PEIA system. They include those from institutional and technical perspectives. As for institutional and political backgrounds, they should be step-wisely improved. For each nation with its own histories and cultures, context-specific political rules and institutions are preferred, those so-called 'outstanding' rules in other nations are not always proper for its contexts. Therefore, the improvement of the watershed-PEIA system will focus on the technical dimension, although the suggestions from the institutional perspective will be discussed. Thus, advanced and appropriate techniques and methods could help improve the veracity of the EIA results under the current contexts. In addition, legislative improvement in the near future is also possible, as an important aspect of contexts.

3.1.4 Stage 4 – Development of the Watershed-SEA Framework Management and Its Indicator System

According to the outputs in Stage 3, the SEA application framework for watershed management in China is developed based on the current watershed-PEIA system and its indicator system is established. Of particular note is that this framework with its indicator system would provide a general groundwork for more systematically implementing watershed-PEIA practices in China; although it will not be applicable to all watershed plans with different scales and unique physical, social and cultural characteristics, it can be used by minor amendment according to the nature of each watershed and the objectives of the plan on study.

3.2 Research Methods

This study intends to build an improved theoretical framework of watershed-PEIAs, based on sustainable development theory, integrated watershed management theory and environmental management theory. The methods adopted in this research include literature review, document analysis, questionnaire and interview, and case study.

3.2.1 Literature review

Literature review may be necessary for all researchers. It is of importance for describing and critically evaluating the studies, related to the proposed research topic, 'synthesize the results into a summary', 'identify areas of controversy' and 'formulate questions' for further research (Taylor, 2008).

In this research, the literature about SEA, watershed management, and their linkage is organized, so that the most current knowledge and ideas on the proposed research topic are provided. The SEA topics to be reviewed include SEA effectiveness, CEA, public participation, the SEA contexts and uncertainties, which are all of great significance for assessing the effectiveness of the selected cases and achieving the research objectives. In addition, the following questions should also be answered and illustrated:

(1) What is watershed management (especially IWM, integrated watershed management)?

(2) Why should watersheds be used for managing water resources and water environments?

(3) What are the differences between watershed plan and regional plan?

(4) What are the factors baffling the effective watershed management at home and abroad?

(5) What are the main environmental implications of watershed developments?

(6) How are the necessity and the rational for the linkage of SEA and watershed management? Or what are the main benefits of SEA in watershed management, in order to realizing sustainable watershed management?

(7) What are the legislations and regulations for requiring SEA in watershed planning processes across the world?

(8) How is the research progress of the SEA theories specific to watershed management?

3.2.2 Case Analysis

This approach uses the literature review method to identify the SEA practices during watershed management processes, especially in watershed planning processes. The selected cases provide the primary basis for evaluating practices, checking the performance based on Overall Effectiveness Criteria in Chapter 2, and identifying the main obstacles in procedures and institutions.

As for the SEA efforts in China's watershed planning processes, selection of the cases is contingent on the availability of the documents, such as watershed planning reports and EIA reports, and their representativeness. In this study, three sets of cases have been selected, which are respectively those in Fujian (the Jiulong River), those associated with Nation-wide Revision of Integrated Watershed Plans (the Yangtze River), and those of watershed hydropower plans (the Muli River). More concerns will be on PEIA cases of integrated watershed plans, because they play their parts at higher levels and could consider cumulative effects in a more comprehensive manner than specific watershed plan. At the same time, PEIA of watershed hydropower plans will also be selected for analyses, because it is the overriding type of watershed-PEIAs in China despite the increasing attention to integrated watershed plans.

3.2.3 Documentary study

Documents vary by type and function. Three types of documents, official documents, news media (such as print media, broadcast, TV, internet and mobile telephone), and academic publications, play different roles in the research (Hui, 2007).

In this research, the official documents include the EIA Law and other regulations, watershed plan reports, and the EA reports. Due to the restricted openness of such documents, their availabilities are disappointing. But this kind of documents is essential for the research. Fortunately, some documents about cases integrating SEA into watershed planning processes have been obtained, part of which were downloaded from the internet with the help of some experts, actors and other participants. As a supplement, print media and online news often provide the most current information about this research field.

Conference announcements, workshop announcements, open official circulars and news, published in all kinds of medias, provide some information about SEA, watershed management and their linkage, as well as the environmental concerns and water resources management focuses in this research region of the government authorities and the academician. For example, the ongoing revision work of integrated watershed management plans, the fourth EIA Storm initiated in July 2007 focusing on 'watershed-Based Limitative Ratification' (Zhang et al., 2007), 'No approval of the hydropower project, if no associated watershed-PEIA' (Wang et al., 2007, http://www.21cbh.com/HTML/2007-9-21/HTML_6SLHNKQ4WIXH.html), all of those information comes from the internet, which helps acquaint the researcher and the readers with the current environmental policies and water resources policies. In addition, several online forums provide many detailed PEIA reports with low availability, as well as some ordinances and regulations and the viewpoints from the EIA actors and advocates, such as *the EIA forum in the China's environmental science and technology network* (http://bbs.cnenv.com/index.asp?boardid=6) and *the EIA Fans* (http://www.eiafans.com/); similarly, some watershed plans and the standpoints of the water planning actors could be obtained from the online forums about water resources management, such as *the water conservancy forum* (http://www.shuigong.com/forum/index.php).

3.2.4 Questionnaire

This method is a time- and cost-effective way for identifying the attitudes, thoughts and experiences of large groups of experts, academicians and actors. Two rounds of questionnaire surveys are conducted, which are respectively the one both for SEA effectiveness study and watershed-PEIA in the First China International Forum on Environmental Impact Assessment held in February 2009, and the one specific to watershed-PEIA by email from April to July in 2009. The questionnaires are used for finding out the current situation of watershed-PEIAs, particularly the main challenges and the research priorities. The details and the outputs will be discussed in Chapter 5.

In addition, the questionnaire was also uploaded in the following EIA forums and hydrological management forums on April 12, 2009, in which some young colleagues are very active:

(1) *The water conservancy forum in the Water Conservancy Projects Network* (水利工程網) (http://www.shuigong.com/forum/index.php).

(2) *The Water Conservancy Forum in Water Conservancy Network of Rivers* (江河水利網) (http://www.jhslw.cn/bbs/index.asp?boardid=6)

(3) *The Planning-EIA Forum in the EIA Fans Network* (環評愛好者，規劃環評論壇) (http://www.eiafans.com/forum-33-1.html)

The deadline for the questionnaire responses was July 1, 2009. When all the responses were collected, the outputs were analyzed.

3.2.5 Interviews

Some unstructured interviews will be randomly undertaken throughout the whole research period. The involved interviewees include the EIA experts, the actors of watershed planning processes, and some officers in water sector. Structured interviews will be conducted from July to October, 2009. The questions designed for the structured interviews and findings are shown in Chapter Five. The main aim of interviews is to obtain some open ideas beyond the scope of the listed questions.

Therefore, flexible talks around the main watershed-PEIA topics, which inspire the interviewees to express themselves without departure from the leitmotiv, are preferred when conducting the interviews. Of particular note, the questions were firstly presented to the interviewees when starting the interviews.

3.2.6 Network Investigation

The viewpoints about the PEIA system in China, the watershed management system and other relative aspects are collected from the online forums and summarized if appropriate. The forums have been mentioned in Section 3.2.3.

3.3 Summary

This Chapter addresses the research arrangement and the methods adopted in each stage. The research road map is shown in Fig. 3.1, which provides the methods for achieving the main research objectives. Of course, one method could be adopted for other objectives, as well as its main objective. For example, case studies could also help to identify the problems in current watershed-PEIA practices, as well as introducing the procedures and methods and exhibiting its effectiveness. The core research objective is to develop a context-specific watershed-PEIA framework, which could be used as guidance of watershed-PEIAs of various levels by more or less amendment.

However, the systematic research in the SEA application system for watershed planning processes is a great challenge. The limitations include: only few literature about this research region for reference, the low availability and the absence of documents related to this field, the experts and actors being unwilling to respond to the questionnaires and the interviews or lacking constructive suggestions due to their poor experience. This thesis is a jumping-off point, offering an initial effort on an systematic watershed-PEIA framework and laying foundations for further researches in this domain. In addition, uncertainness in watershed-PEIAs is also a big gab to be considered, so that the development of such SEA application system is not a piece of cake.

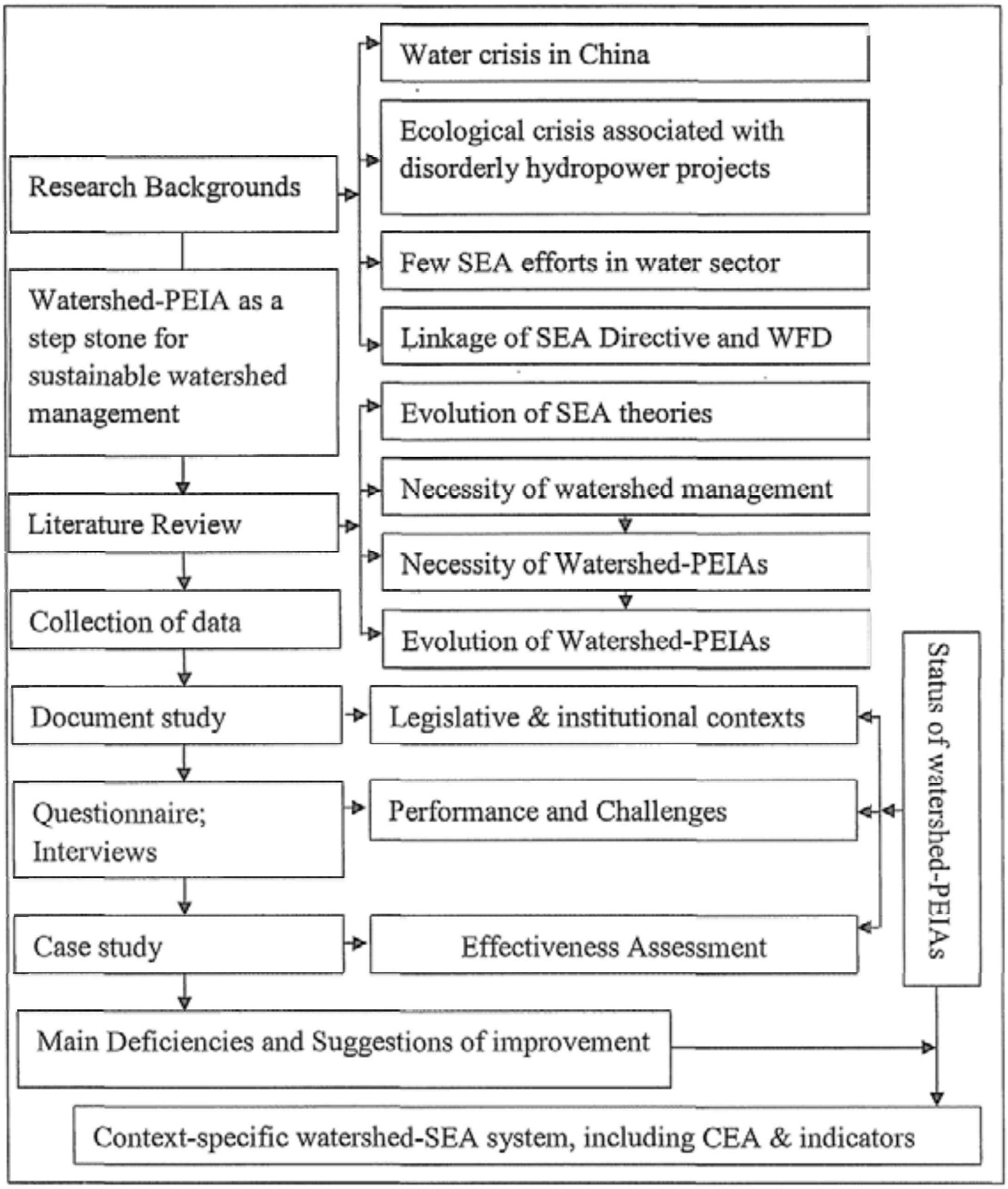

Fig.3.1 Research Road Map

Chapter 4 Legal and Institutional Arrangements of Watershed-SEAs

This chapter aims to identify the current legal and institutional frameworks, mainly based on the outputs from the analysis of the available documents (articles, reports and news). Those outputs help understand the evolution of the watershed-PEIA (Plan-EIA, environmental impact assessment for plans) system in China, to identify and flag up the current and future institutional challenges, and to provide the current institutional framework. Although part or even most problems could not be addressed at once, it is important to recognize them for developing creative solutions and exploring the right direction.

4.1 Overview of EIA and SEA Policies and Laws in China

In China, the SEA (strategic environmental assessment) practices focus on PEIA, which is the headstone of implementing SEA in various sectors of China. It is the core requirements of The 2003 EIA (environmental impact assessment) Law to apply environmental assessment to the planning processes of the following plans: land plans, regional, watershed and sea area plans, and 10 special plans, as well as the project-EIA (environmental impact assessment for projects). The ins and outs of the 2003 EIA Law and other related prescriptions are to be discussed in the following sub-sections.

4.1.1 General EIA Policies and Laws

(1) Project-EIA Policies and Laws (Tab. 4.1)

EIA has experienced a long history of development since the first environmental protection conference held in China in 1973, which introduced the concept of EIA into China. *The Environmental Protection Law of the People's Republic of China* (for Trial Implementation) was promulgated in 1979, which established the EIA system of programs. *The Environmental Protection Law of the Peoples Republic of China* was adopted in 1989, based on the first trial one in 1979. *Management*

Measures of Environment Protection of Capital Construction Project issued in 1981 involved EIA in the approval procedures of construction projects and regulated its specific steps. *Measures on Environmental Protection Management for Construction Projects* and *Trial Measures on Environmental Protection Management for Construction Projects*, adopted in 1986, respectively established the specific contents of EIA and required the relevant competence and qualification of the environmental assessment organizations. At that time, the construction projects subject to EIA included technical innovation projects and regional development projects, as well as capital constructions projects. In 1998, *Regulations on Environmental Protection Management for Construction Projects* comprehensively prescribed the EIA system for construction projects in full details, which included the requirement of relevant qualification certificate, the contents of EIA reports, the time of submitting the reports for approval and relevant legal responsibility, based on previous *Technical Guidelines for EIA* and *Specification for Formulating Environmental Impact Report. Measures on Environmental Protection Management for Construction Projects* were formally promulgated in 1999, which prescribed the qualifications of the environmental assessment organizations.

The requirement of qualified EIA agencies and actors has helped produce many proficient actors, equipped with broad EA (environmental assessment) knowledge and assessment methods. More details and regulations in the policies and laws, specific to project-EIA in China, have promoted the smooth processes of project-EIAs in some sense. However, the extent to which the EIA outputs are integrated into the decision-making process is the product of the conflicts and competitions between various groups of interests with different powers, which is limited by contexts at various levels. Moreover, even successful project-EIAs also need the framework provided by SEA at higher levels.

Tab. 4.1 Policies and Laws in China (Project-EIA)

Year	Laws and Regulations	Main Contents
1979	The Environmental Protection Law, PRC (for Trial Implementation)	The EIA system of programs
1989	The Environmental Protection Law, PRC	
1981	Management Measures of Environment Protection of Capital Construction Project	The involvement of EIA in the approval procedures of construction projects and its specific steps.
1986	Measures on Environmental Protection Management for Construction Projects	The establishment of the specific contents of EIA and the requirement of the relevant competence and qualification of the environmental assessment organizations
1998	Regulations on Environmental Protection Management for Construction Projects	Prescribing the EIA system for construction projects in full details
1999	Measures on Environmental Protection Management for Construction Projects	Prescribing the qualifications of the environmental assessment organizations

(2) SEA (PEIA) Policies and Laws (Tab. 4.2)

The above-mentioned laws, regulations and technical guidelines confined the EIA into the project level, despite great improvements in techniques, procedures and enlargement of the ranges subject to EIA. *The EIA Law*, which came into effect in 2003, was a milestone on the road to realizing effective environmental protection and sustainable development in China. Subsequently, other associated laws, regulations and ordinances have been enacted in succession. However, the SEA legislation is still far away from a complete system. Among them, *The 2003 EIA Law*, *Technical Guidelines for PEIA (on trial)*, *Ordinance of PEIA*, *Regulation for EIA of Watershed plans (SL45-92)* and *Regulation for EIA of Watershed plans (SL45-2006)* should be of particular concern in this research.

1) The 2003 EIA Law and Technical Guidelines for PEIA (on trial)

The EIA Law required conducting environmental assessments in planning phases for a select set of planning activities such as land-use plans, watershed plans, regional plans and some special plans. Thus, for the first time, the environmental authorities were provided by the law with legal means to intervene in the planning and implementation of construction projects in China, despite its limited scope, its limited requirements for information disclosure and public participation in PEIA, and the ambiguous role of environmental authorities (Zhu et al., 2007).

As for *The 2003 EIA Law*, some deficiencies exist. Theoretically, it is too simple to fully embody issues such as 'post-assessment', 'alternatives', 'monitoring and follow-up' and 'public participation', which follows a legislative tradition in China of a rough law and its subsequent fine points specific to each sector (Kong, 2005). Thus, the regulations established by each sector (such as water sector, urban-planning sector, land-use sector and coal industry) tend to protect their own sector interests. For example, water-related sector has established and revised the specific EIA fine points in Regulation for EIA of Watershed plans (SL45-92, SL45-2006).

In addition, it has brought 14 kinds of plans under the EIA coverage of China, but no provisions are enacted on EIA for policies and legislations. As shown in Chapter 2, it is desirable to bring policies, strategies, and legislations into the EIA-law system.

Furthermore, the experts and agencies examining the EIA report play a crucial role in making it approved. In practice, nevertheless, the common 'internal assessments and examinations' often lead to the low quality of PEIA and make it a mere formality. Moreover, the legal liabilities of the EIA actors and the examiners have not been legally required, which should be added to the existing EIA law, together with clear-cut examination procedures. Also, the legal liabilities of failing to implement public participation should also be laid down.

Finally, the authorities responsible for examination and approval of the EIA report are the decision-makers. That is to say, the government agencies determine whether or not the environmental implications are to be considered and they tend to put their own interests, local or sectoral, at the decision center.

Following *The 2003 EIA Law*, the issuance of *Technical Guidelines for PEIA* (on trial) provides the principals, technical procedures, methods and contents for general SEAs. It is also the technical framework of the SEA process in each specific sector. In water sector, it provides the introductory and illuminating ideas for the following 'regulation' (SL45-2006).

The introduction of SEA into China can be dated back to the early 1990s and lots of researches and practices related to SEA for all key government activities were conducted before 2003. However, SEA did not become a formal administrative practice until the inclusion of SEA in *The 2003 EIA Law*, which was an intermediate solution for integrating environmental factors into early stages of government's policy-making (Zhu et al., 2007). However, it is unfortunate that the policy-EIA section in the first draft be excluded due to the resistance from national non-environmental interests within the government (Wang, 2002; Qu, 2002; Zhu et al., 2007). Moreover, similar to *The European Union Directive 2001/42/EC* (*The SEA Directive*), *The 2003 EIA Law* does not really contain a strategic emphasis, or even does not refers to SEA, which is cutting off SEA's full potential and capacity (Sadler, 2007). Even so, *The 2003 EIA Law*, accompanied by the '*Technical Guidelines*', still should be ranked as SEA Legislations.

2) *Ordinance of PEIA*

The 2003 EIA Law is a milestone in the environmental legislation in China, which establish the PEIA system for the first time. However, examiners, examination procedures, and rights and obligations of each party are not clearly regulated. *Ordinance of PEIA* (Consultative Draft Dated 28th March, 2008; The Final Version taking effect on 1st October, 2009) provides the fine prints of implementing PEIA and strengthens the operability and practicality of PEIA, despite many details having been deleted from the draft.

The 'Ordinance' is of legal effect, which demonstrates the willingness of the national government to take lead in improving the environments from the root. It focuses on the following aspects: examination and approval, legal liabilities, monitoring and follow-up, and public participation. 'Ordinance' regulates the de jure role of the environmental sectors in the examinations of PEIAs, for avoiding the 'self-examination' of PEIAs de facto.

As for the each associated agencies, the 'Ordinance' regulates their respective rights and obligations. The planning agencies, the technical agencies of EIA, and the environmental authorities at various levels are respectively responsible for organizing the EIA process, assessing the environmental implications, examining and approving the EIA documents. Their managers and other persons with direct responsibilities shall bear legal liabilities in their scopes of duties in case of employing trickery and neglecting duties, which provides the supports for effective and objective PEIAs, together with the integration of the EIA costs into the financial budgets. However, it is a great pity that the 'Ordinance' fails to regulate the liabilities of 'inactions' and those of the planning agencies associated with conducting 'internal assessment'. In addition, no provisions exist in the 'Ordinance' about how to coordinate the interests and rights of various sectors.

Although the chapter about public participation in its draft has been deleted, the public have been endowed with more rights, such as the right of further arguments when a major difference exists between planners, experts and the public, and the right of consulting the approval documents. Moreover, in the EIA document, the rational explanations about the comments from the public should be attached, whether the comments are accepted or rejected. Or else, the EIA document needs to be revised and reexamined. However, in practice, enough and proactive responses from the public may be still the extravagant expectations of the environmentalists, because there remain no enough concerns of the general public on the environments.

Tab. 4.2 Policies and Laws in China (SEA in general)

Year	Laws and Regulations	Main Contents
2003	The 2003 EIA Law	Conducting environmental assessments in planning phases for a select set of planning activities such as land-use plans, watershed plans, regional plans and some special plans such as water conservancy planning.
2003	Technical guidelines for PEIA (on trial)	Regulating the general principals, procedures, methods and contents of PEIA
2003	Technical guidelines for EIA of development areas	Regulating the general principals, procedures, methods and contents of EIA for development areas
2008	Measures for the Disclosure of Environmental Information (for Trial Implementation)	Requiring environmental administrations to disclose the EIA information for construction projects and to the public, and encouraging the enterprises to disclose their environmental information.
2009	Ordinance for PEIA	Providing the details of implementing PEIA

Besides the above highlights, the 'Ordinance' also adopts the comments from NGOs, such as the environmental authorities being responsible for examination and approval of PEIAs. However, the local environmental authority is affiliated with the local government of its same level, whose human resources and financial resources are heavily reliant on the corresponding government, rather than Ministry of Environmental Protection, PRC. Thus, the practical rights of examining and approving PEIAs are, de facto, still in the hands of the decision-makers, which may lead to an impasse of 'internal examination' again. In addition, the operational details of public participation need to be improved, such as the associated time periods, rights, and the regulations about the confidential contents and the security rating. Anyway, the announcement of the 'Ordinance', undergoing 18 amendments in 3 years or more and competitions between various interest groups, is another milestone, succeeding *The 2003 EIA Law*, in the EIA evolution of China.

3) *Other Laws and Regulations*

Measures for the Disclosure of Environmental Information (for Trial Implementation) have been promulgated and came into force on May 1, 2008, which requires environmental administrations to disclose the EIA information for construction projects and to the public and encourages the enterprises to disclose their environmental information. The Trial has the potential for promoting the public participation in SEA for all PPPs, in spite of some resistance from many aspects, which will be discussed later in more detail.

4.1.2 EIA Policies and Laws Specific to Water Sector (Tab. 4.3)

With the development of general EIA and SEA institutions and relative laws, some special policies and regulations of EIA and SEA in water sector have been adopted one after the other. According to their provisions and requirements, formulation of EIA polices and Laws in water sector could be categorized into two phases: Project-EIA Stage (1982-1993) and Stage of Equal Attention to Project-EIA and PEIA (1993-).

The Project-EIA Stage when the legal and policy provisions for EIA were laid down and implemented primarily at the project level under EIA legislations and polices in water sector. For example, *Provisions on Environmental Impact Assessment for Water Conservancy and Hydropower Project* was established in 1982 and *Regulations of EIA for Water Conservancy and Hydropower Project (on trial) (SDJ 302-88)* was promulgated in 1988. *SDJ 302-88* prescribed the obligatory implementation of EIA during the feasibility-study period of water conservancy and hydropower projects, with EIA statement, and detailed the EIA procedures, scope and the outline of EIA reports. *Code for EIA of Water Conservancy and Hydropower Project (HJ/T 88-2003)* was issued for enforcement in 2003, which was a amended edition of *SDJ 302-88*. The code required confirmation of the EIA contents according to the project type, and added some techniques about environmental economics and stakeholder participation.

Stage of Equal Attention to Project EIA and Planning EIA (1993-) when varied provisions have been made for project-EIA and PEIA. *Regulation for EIA of Watershed plans (SL45-92)* was implemented in 1993, applicable to watershed-PEIAs, which prescribed the environmental objectives, EIA procedures and contents for watershed plans and required EIA throughout the entire planning process. In addition, *SL45-92* also mentioned the environmental effects of cross-basin water transfer. Regional environmental assessment was also required to be conducted for watershed development plans in the supplementary articles of *Regulations on Environmental Protection Management for Construction Projects* in 1998. *Notice about Strengthening Environmental Protection Work of Hydropower Construction* in 2005 attached much importance to EIA for hydropower development. In addition, the amended version of *SL 45-92* added the contents such as planning analyses, planning alternatives, public participation, environmental monitoring and tracking assessment. Three appendices were also included in the new version, *SL 45-2006*, which were respectively the syllabus of the EIA report, the environmental objectives and indices of watershed plans, and the estimation methods of ecological water demand in the watercourse. Both *Regulation for EIA of Watershed Plans (SL45-92)* and *Regulation for EIA of Watershed Plans (SL45-2006)* require EIA reports in watershed planning reports. Ministry of Water Resources (hereafter MWR) promulgated *Measures on Environmental Protection for Rural Hydropower Projects* in 2006, based on *EIA Code Hydroelectric Station Project for Rural Area (SL315-2005)*, which required Environmental impact report for all rural hydropower projects before they are approved, and regulated its contents and EIA process.

Regulation for watershed-PEIAs

Regulation for EIA of Watershed Plans (SL45-92) was established mainly for EIAs of watershed planning processes, which prescribed the major contents of EIA for watershed plans: survey on the environmental status, establishment of the environmental objectives, identification, evaluation and assessment of environmental consequences of planning alternatives, edition of the EIA chapter or the specific report of the project with serious environmental impacts. It is earlier than the promulgation of The 2003 EIA Law, which promotes the early EIA efforts for watershed plans despite those SEAs are of no legal effect.

In this regulation, no EIA report is required. Generally, the watershed boundaries or the planning watershed parts are generally similar to the EIA boundaries, but the spatial scale of environmental survey and EIA may be larger than the planning scale if environmental consequences are likely to extend outside the watershed. The required EIA procedures of watershed planning are as follows: identifying the environmental elements, screening the key environmental elements, estimating the likely environmental impacts of each planning alternative on each key element, assessing the overall impacts of each planning alternative on the watershed environments. In this regulation, Cross Impact Matrix Method is introduced for reference when identifying the environmental elements. List Method is generally adopted for assessing the overall impacts of each planning alternative and Region-Control Weight Method is also useful if available baseline data is enough. Here, the overall impacts are the addition of individual projects in each alternative, which are only a small portion of all the cumulative effects. In brief, it is very rough with a need to be improved, although the EIA contents and the involved methods are still useful at present.

For meeting the new EIA Law, *Water Law of the People's Republic of China*, *Technical guidelines for PEIA (on trial)*, and *Regulation for EIA of Watershed Plans (SL45-2006)* was issued, revising the 1992 version. At present, it works as *the technical framework* for watershed-PEIAs. The contents about plan analysis, comparing the alternatives' environmental consequences with the environmental trends of 'no-development' alternative in the target year, measures for avoiding and mitigating environmental negative impacts on water resources, land resources and special habitats, public participation, monitoring and follow-up have been added to the latest version. In addition, the outlines of the EIA report and the EIA chapter, the environmental objectives and indicators, the calculation of ecological water demand in river channels are also illustrated. This regulation has wider application, covering both integrated and specialty plans in a watershed and it also provides references for regional planning. The procedures are as shown in Fig.4.1, showing that public participation is not involved at the start of the EIA process and the later stages, which strikingly limits the roles of the public. The preliminary plan is made at the stage of conducting plan analysis, earlier than the survey on the environmental status, which virtually often reach an impasse of a passive EIA, some projects in the plan having been approved in advance or started by the governments. The appropriate methods at each stage are listed for reference (data collection, field survey, monitoring and remote sensing for investigating environmental status; overlays, checklists, matrices, networks, flow charts, analytic hierarchy process, scenario analysis for identifying environmental impacts; analogy method, system dynamics, input output analysis, mathematical models, scenario analysis, overlays, ecological mechanism, landscape ecology for predicting environmental consequences; weighted comparison, environmental quality index, analytic hierarchy process, comparative analysis, environmental carrying capacity, evaluation of sustainable development capacity for assessing environmental consequences; comparison, weighted comparison, and expert consultation for comparing the alternatives and prioritizing them), but their actual applications need to be deliberated over based on the nature of the watershed under assessment and its associated planning objectives. In addition, CEA (cumulative effect assessment) is mentioned, despite no details, which is above all in environmental consideration during the whole planning process and also is a knotty job.

This new version exhibits many technical improvements and details, but it is still administrative, not legal, which is within the power of Ministry of Water Resources, the State Council, rather than under the supervision of the People's congress at various levels. Therefore, its effective implementation is a matter for argument because none of the decision-makers or the EIA experts has been legally punished or is to be legally binding for his behavior in this domain.

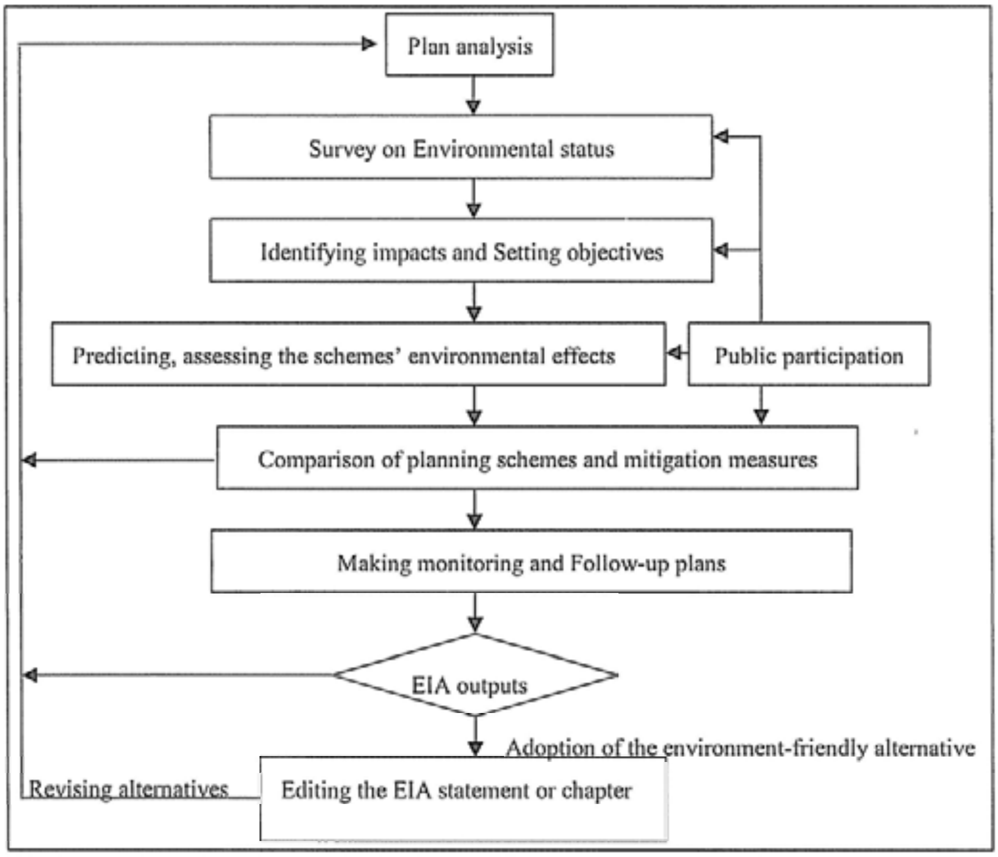

Fig. 4.1 Watershed-PEIA Procedures (SL45-2006)

Brief Summary

Obviously, EIAs for watershed plans and cross-basin water transfer were required in early 1990s, earlier than The 2003 EIA Law. Among the 14 Planning typologies required for EIA, 'watershed plan', nevertheless, is still the most headachy one for the EIA actors. The core barrier may be the concurrence of watershed management and administrative regulations. In addition, according to *Ordinance of PEIA*, integrated watershed planning requires the EIA introduction or the EIA chapter in the plan, rather than the report. But in '*Specific scope of preparation of EIA Reports (On trial)*' and '*Specific scope of preparation of EIA Chapters or Introductions (On trial)*', there is no explicit regulation on integrated watershed plans. In addition, other related documents such as the EIA framework and the detailed technical report are not required, which are necessary for ensuring the timely technical managements and revisions.

4.2 Water Management System in China

Watershed management is not new in China. *Water Law, PRC, Flood Control Law* and *Law on Prevention and Control of Water Pollution, PRC* have established the current watershed-based water resources management system in China. In addition, 'for convenient water resources planning and management,' 'China was divided into nine water resources zones' and seven water resources commissions were established as management organization (Pei, 2003; Wang, 2005).

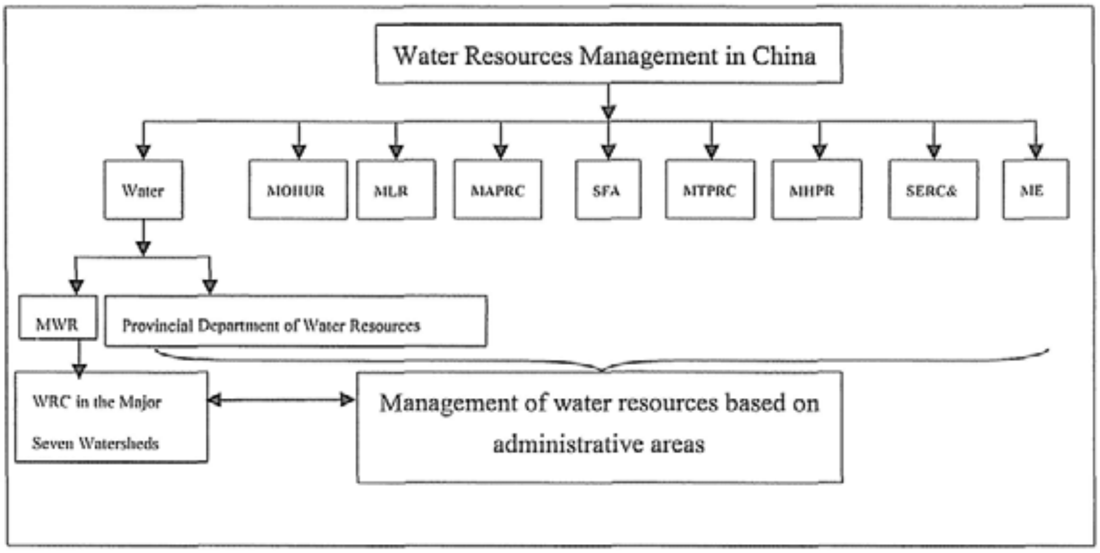

Fig. 4.2 Water Resources Management System in China

Tab. 4.3 Policies and Laws for EIA (including SEA) in China's Water sector

Year	Laws and Regulations	Main Contents
1982 (Project-EIA)	Some Provisions on EIA for Water Conservancy and Hydropower Project	Obligatory implementation of EIA for water conservancy and hydropower projects
1989 (Project-EIA)	Regulations of EIA for Water Conservancy and Hydropower Project (on trial) (SDJ 302-88)	
1993 (PEIA)	Regulation for EIA of Watershed Plans (SL45-92)	EIA for integrated river planning and cross-basin water transfer
1998 (PEIA)	Supplementary articles of Regulations on Environmental Protection Management for Construction Projects	Regional EIA for watershed development plans
2003 (Project-EIA & PEIA)	Code for EIA of Water Conservancy and Hydropower Project (HJ／T 88-2003); The 2003 EIA Law	Requirements for confirming the EIA contents according to the project type, and some techniques about environmental economics, stakeholder participation; Requirements of watershed-PEIAs
2005 (Project-EIA)	EIA code hydroelectric station project for rural area（SL315-2005）	Requirements of EA statements for all rural hydropower projects; regulating the contents of the EA statements and EIA review process
2006 (Project-EIA)	Measures on Environmental Protection for Rural Hydropower Projects	
2006 (PEIA)	Regulation for EIA of Watershed Plans (SL45-2006)	A revised version of SL45-92, adding the contents of planning analyses, planning alternatives, public participation, environmental monitoring and tracking assessment

Tab. 4.4 Sectors Involved in Water Resources Management

Sectors		Main Responsibilities
Water Sectors	Ministry of Water Resources and its underlings	Manage the country-side water resources based on river basins
	Provincial Department of Water Resources and its underlings	Manage the water resources in their respective administrative regions
Ministry of Housing and Urban-Rural Development		Ground-water in urban-planning area; Water supply and sewage drainage in cities
Ministry of Land and Resources, P.R.C.		Groundwater detection and evaluation of groundwater storage
Ministry of Agriculture, PRC		Water areas for fisheries
State Forestry Administration		Water and soil conservation
Ministry of Transport, PRC		Inland shipping
Ministry of Health, PRC		Establishment of drinking water standards
The State Electricity Regulatory Commission		Large-scale hydropower engineering
The Ministry of Environmental Protection		Protection of water environments

Previous watershed plans, especially the integrated ones, have, more or less, played an important role in protecting, improving and restoring watershed environments and ecosystems. However, the high complexity of current water resources management system is baffling sustainable watershed management.

4.2.1 Sectors Involved in Water Resources Management in China

The following nine sectors involved in water resources management are often compared to 'nine dragons playing with water' (Fig. 4.2). Each sector has its own main responsibilities, as shown in Tab. 4.4.

Water Resources Commissions, as the subordinates of Ministry of Water Resources, play some parts mainly by providing technical services. They have no powers for macroscopical management of water resources. Provincial Department of Water Resources and their subordinates are under the control of their local superior governments, rather than Ministry of Water Resources. The provincial agencies in other involved sectors also function, mainly by complying with its provincial governments and combating for local interests and their own interests. Thus, various conflicts exist between sectors, between the central government and the local governments, between administrative regions, between the upper and lower reaches, between the main stream and the tributary rivers. As for watershed-PEIAs, conflicts exist mainly between Ministry of Water Resources, Ministry of Environmental Protection and the associated local governments, which are difficult to be overcome. Moreover, limited information openness and administrative-power-dominated management also restricts the integrated watershed management of water resources and watershed environments.

4.2.2 Main Problems in China's Water Resources Management

(1) Conflicts among Sectors

In the complex water management system, the following problems are of particular note: 'partition of surface water and groundwater management', 'partition of urban and rural water utilization management', and 'partition of water quantity and water quality' (Wang, 2005), which indicate that great conflicts exist between those sectors. In addition, the above partitions also imply 'overlapped authorities and vague responsibilities' in the involved sectors (Wang, 2005). Therefore, on one hand, they are inclined to struggle for interests by hook or crook, but tend to pass the buck due to their ambiguous responsibilities and obligations.

(2) Conflicts between Watershed Management and Administrative Management

Moreover, the conflicts between watershed management and administrative management of water resources are also intractable. The current watershed management agencies lack its deserved legal authority for fighting the powers of local governments and lack the function of balancing the relationships between the above nine sectors. Administrative powers of local governments weigh much more than water management commissions in dealing with water affairs. Therefore, the conflicts between administrative regions are terribly hard to be solved due to local protectionism and the restricted managerial authority of water resources commissions.

(3) Limited Information Sharing

Due to partitions of interests and powers among various sectors, they are unwilling to provide their data to others. Large amount of money has to be paid for obtaining the data about hydrology (Water Resources Commissions), water quality (environmental sectors) and groundwater (Ministry of Geology and Mining). Thus, limited information sharing becomes a big obstacle of limiting watershed development and management.

(4) Lack of Market Mechanisms as Management Measures

Further, administrative management is dominant in water resources and watershed management. Effective market measures have attracted increasing concerns for managing watershed water resources. However, adopting the market principle in water-related management is troublesome, due to the multiple attributes of water resources and the equity across the whole watershed (Wang, 2005).

The latest version of *Water Law, PRC,* accompanied by the institutional reform of watersheds agencies in 2001, established the current water resources management system, linking watershed-based management and administrative management. Watershed management agencies were endowed with administrative and legal powers of managing water resources. It is a great progress in water resources management. However, in practice, watershed-based management is still confronted with difficulties, for instance, how to distinguish the jurisdiction of watershed agencies and local governments for each kind of water affairs.

In addition, the establishment of Shanghai Water Affairs Bureau is an important trial for unifying water resources management in a single agency, which is responsible for managing water affairs and oceanic affairs in Shanghai, intending to change the traditional 'nine dragons playing with water' into the current 'one dragon controlling water resources'. Comparatively, this institutional reform is a great improvement in water resources management. However, functionally, it is dominated by Shanghai municipality and still has difficulty in harmonizing the relationships between Shanghai and its neighboring administrative regions.

At present, government actions still dominate in water resources and watershed management. Public involvement has little opportunity for participating in watershed management. Their opinions are seldom adopted, even if they have taken part in it.

4.3 Summary

This chapter analyzed the general EIA laws and regulations and those specific to water and watershed management. Among the long list of laws and regulations, *The 2003 EIA Law*, *Technical Guidelines for PEIA*, *Ordinance of PEIA*, and *Regulation for EIA of Watershed Plans (SL45-2006)* were particularly discussed.

The 2003 EIA Law is the first law regulating environmental agencies to intervene in the planning process. However, many deficiencies exist, which mainly include no details about 'post-assessment', 'alternatives', 'monitoring and follow-up' and 'public participation'; no provisions enacted on EIA for policies and legislations; no clear regulation about examiners and examination procedures; no regulations about the liabilities of each responsible one. It follows a legislative tradition in China: a rough law and its subsequent fine points specific to each sector. For example, procedures and requirements about watershed-PEIAs are provided by *Regulation for EIA of Watershed Plans (SL45-2006)*. Thus, the sector tends to protect their own interests when establishing the sectoral regulations.

Ordinance of PEIA is another milestone succeeding *The EIA Law*, providing the details of implementing PEIA and strengthening its operability. It focuses on provisions about examination and approval of PEIAs, legal liabilities, follow-up and monitoring, and public participation. Nevertheless, it fails to regulate the liability of 'inactions' and 'internal assessment'. In addition, public involvement was deleted from the draft one.

As for *Regulation for EIA of Watershed Plans (SL45-2006)*, it works as the current technical framework of watershed-PEIAs, accompanied by *Technical Guidelines for PEIA (on trial)*. No detailed regulation of CEA is its main deficiency.

The above analyses indicate the continuous improvements in the EIA legislation. However, failure to observe the law and slack enforcement is one of the critical factors accounting for the effective implementation of PEIAs. Therefore, the supervisions of NGOs and the general public are essential.

In addition, watershed management system was also expounded, which is characterized by extremely complicated relationships between nine sectors and even more. The main limitations include conflicts between sectors, conflicts between watershed management and administrative management, limited information sharing, and lack of market mechanisms as management measures. For overcome the above limitations, Chapter 6 gives ideas about how to improve it under the current political contexts.

However, current management system is formed by continuous evolutions of many years. It is impossible to overthrow it at once. It is advisable to find appropriate management measures under the current system, accompanied by stepwise reform.

Chapter 5 Cases, Challenges and Performance

In this chapter, various methods will be adopted for analyzing the practices of watershed-PEIAs in China. Literature analysis and document study help to understand what cases have been undertaken. Then three representative cases will be particularly assessed based on SEA performance criteria (Chapter 2). Questionnaires and interviews intend to canvass the recent progress, current challenges and research priorities in the SEA system for China's watershed management.

5.1 Watershed-SEA Cases

EIA practices for water resources and hydropower projects, which have been the focus of EIA during a long time, in China, started in 1979, together with the commencement of *The 1979 Trial Law*. In addition, there have been large amounts of SEA-type practices on watershed planning and trans-basin Water Transfer projects, which have involved parts or all contents of SEA since 1980s (Zou and Lei, 2001). For example, EIA for Three Gorges Dam and South-to-north Water Transfer Project has been conducted before their operation due to their comprehensive and complex environmental impacts, although literatures discussing environmental impacts of the Three Gorges Dam and South-to-north Water Transfer Project show inconsistent conclusions. However, EIA in China's water sector are mainly for projects, rather than for planning activities and policies (Jiang, 2005).

Watershed plans cover a wide range of areas, including hydropower plans, flood control plans, water use plans, shipping plans and irrigation plans and so forth, as well as integrated watershed plans. Integrated watershed plans and special watershed plans for flood, hydropower and so forth have different potential environmental effects due to diverse contents. In regard to this, the following sub-sections concentrate on respectively analyzing the EIA cases for integrated watershed plans and specific watershed plans such as hydropower plans and so on. In this study, EIA for integrated watershed plans is in the spot light, and overview of the EIA cases for various specific plans also help the readers comprehend the status of the research topic. Further, EIA for water polices will be discussed in brief.

5.1.1 EIA for integrated watershed plans

PEIA is the cut-in point of SEA in China, and watershed-PEIA, especially for integrated watershed plans, is the cut-in point of SEA in China's water sector. However, based on the investigation of Ministry of Water Resources, PRC, there is still a big gap in integrated watershed plans in China and even no integrated watershed plans have been prepared when constructions of hydropower projects are initiated in some watersheds, not to mention PEIAs for them (Zhang, 2007). In addition, integrated watershed plans in use can't reflect the recent changes in the watershed systems and the recent developments in social-economic systems. In view of this, nation-wide revision of integrated watershed plans has been initiated in 2007 and has almost been finished.

Watershed-PEIAs in China can date back to 1980s, in which the first trial was conducted in the Dongjiang Watershed, Guangdong Province, China. The EIA for the Dongjiang Watershed, which was retrospective, based on the completed projects, aimed to seek effective methods for watershed-PEIAs and indeed provided helpful experiences. In addition, another case in the 1980s is available, which assessed the environmental consequences of the Watershed Plan in the Xinjiang Watershed of Jiangxi Province (Chen, 1985). The Dongjiang case intended to be a trial in the humid areas, but the case in the Yeerqiang Watershed was a trial in the arid northern areas. The watershed-PEIA for the Yeerqiang Watershed spent four years of efforts from 1987. The above two trials provided the examples and references for the establishment of *Regulation for EIA of Watershed Plans (SL45-92)* (Zhu, 1992; Han, 1992). For example, the regional weighting approach adopted in the two trials may be still important for today's EIA.

In 1990s, fewer cases were mentioned for watershed plans, except the case of the Yangtze River Basin (Zou, 2001). The comparatively fewer available literatures and documents than that in the 1980s and in the 2000s show the near stasis of the researches in the 1990s.

In 2000s, especially after *The 2003 EIA Law*, the first legal requirement for watershed-PEIAs, relevant information is increasing both in journals and medias. The new round of integrated watershed plans, the pilot watershed-based PEIAs and the requirement of limiting the approval of hydropower projects without watershed-PEIA bring the study into prominence. The ongoing revision of integrated watershed plans focuses on the Major Seven Rivers and trans-boundary rivers in Southwest China. In addition, most provinces have commenced their respective revisions and prepared the revising outlines of integrated watershed plans, such as Fujian, Guangdong, Shanxi, Shaanxi, Jiangxi, Qinghai and others.

Among them, Fujian is receiving particular concerns due to its great efforts in watershed-PEIAs. Comparatively, Fujian has its own dominance for implementing the watershed plans and the relevant PEIAs, because most rivers flow within this province and seldom need to consider the trans-province interactions. Moreover, in Fujian, most watersheds are almost independent from the impacts from any of the Major Seven Watersheds. In 2006, Fujian Province started up EIAs for integrated watershed plans, which included 68 watersheds, the area of each watershed being more than 500 km^2; in 2008, PEIAs were required for 905 watersheds, each of which is less than 500 km^2.

According to the above analysis, this new round of revision takes measures from two ways: the watershed-based one and the province-centered one. The watershed-based one intends to address the planning tasks in large-scale watersheds, which often span many different provinces. The province-centered or even county-based one generally focuses on those small-scale watersheds, such as the cases in Fujian. However, those two ways often work by interacting with each other.

In practice, large-scale watersheds are often divided into several administrative areas for facilitating data collection and inter-provincial coordination, when establishing integrated watershed plans. For instance, the 10 provincial revision groups are respectively responsible for the tasks associated with the watershed plan of the Yellow River. The revising outline for each province is sometimes classified into different parts, based on the watersheds located in the province, such as Shandong, which are divided into three watershed areas: the Yellow River, the Huai River, and the Hai River. These phenomena show the complex conflicts between watershed management and administrative management of water resources and water environments in China.

The consummation of the above planning tasks should be supported by EIAs, integrating environmental considerations into them. However, few of them have initiated EIAs at early stages. Few successful cases of EIA for integrated watershed planning have been achieved in China and some of them are being conducted. Moreover, environmental problems caused by prevailing constructions of small hydropower projects also testify insufficient and non-effective EIAs for watershed plans. The technologies and methods necessary for watershed-PEIAs lag behind the requirements of watershed developments. Therefore, it is pressing to take EIA into account during earlier stages of watershed planning and in the whole planning process. In addition, it is the core of watershed-PEIAs how to integrate all the environmental influences from complicated factors in the whole watershed into the development plan, which is still not mature and needs further improvements (that identifies the necessity of. CEA - cumulative effect assessment).

5.1.2 EIA for Special Watershed Plans: Watershed Hydropower Plans

Generally, an integrated watershed plan includes plans for specific topics such as hydropower plans, flood management plans, shipping plans and water supply plans and so on. EIAs for the above-mentioned single-purpose plans are also required to be conducted as well as EIA for integrated watershed plans. However, EIA about the special planning parts of the integrated watershed plan can only give a curt introduction about their environmental potentials, because the ins and outs of each specific plan are not available during the integrated watershed planning period. In addition, the EIA outputs of integrated watershed plan can also influence the planning process of each specific plan, which establish the framework for its specific plans and their EIAs.

Hydropower has always been one of the focuses of decision-makers and experts to promote the exploitation of renewable energy resources. However, large-scale development of hydropower since the 1980s, especially the prevailing development of mini- and micro hydropower recently, has caused ecological crisis due to lacking effective watershed-PEIAs for considering their cumulative effects. For example, a 34km river in Shimian County, Sichuan Province has 17 hydropower stations, including completed and building ones, which have led to dry river sections and breaking groundwater. Therefore, governments should make efforts to plan hydropower developments in a watershed context and should give due weight to environmental and social factors during the planning process, as well as economic and financial factors (Beijing Declaration on Hydropower and Sustainable Development).

Some groping of EIA practices for hydropower projects has been conducted since the early 1980s. Large and medium-sized hydropower projects have been included in environmental management since the later 1980s (Gu, 2007). Nevertheless, EIA for individual hydropower project loses sight of cumulative effects of watershed cascade developments on ecosystems and environments. In fact, despite their faultiness, EIA efforts for hydropower planning have been made since the early 1980s based on *Suggestions on Strengthening Hydropower Planning*. In addition, *Specification on Compiling Hydropower Planning of River* (DL/T5042-95) issued in 1996 elaborated the requirements, contents and procedures of EIA for cascade development planning of hydropower. With the issuance and implementation of some regulations associated with EIA for hydropower plans, such as *SL45-92*, *SL45-2006* and *DL/T5042-95*, more and more EIA practices for such plans have been conducted, especially after *The 2003 EIA Law*.

Based on the regulations and relevant policies, since 2003, EIAs for cascade development plans of hydropower have been initiated in the following middle and small-sized watersheds: the Talimu River, the Lancangjiang River, the Daduhe River, the Nu River, the Yalong River and the Wanshui River (Gu, 2007; Xue, 2007). In Sichuan Province, EIAs for cascade development plans of 21 rivers have been developed at the end of 2005. Thereinto, EIA for hydropower development plans of the Nu River provided solutions for mitigation and prevention measures by comparison of two alternatives; the case of the Dadu River addressed the tradeoffs between environmental considerations and development, so that the potential inundation area and migration population would be reduced.

With the development of EIA for hydropower plans, there have been some relevant researches about the technologies, such as GIS, and the index system. Zhang et al. (2006) elaborated on the significance of EIAs for hydropower plans, and the following aspects: public participation, alternatives, cumulative environmental effects and key principles are obtaining increasing concerns. Gu et al. (2006, 2007) and Xue et al. (2007) respectively established different index systems for environmental impacts evaluation in watershed hydropower plans through summing up the experience in recent years in China. Xue et al. (2007) also developed an integrated assessment model, grounding on the quantification and the three-tier system of 'the indices through analytic hierarchy process (AHP). These index systems provide foundations for future practices, although they couldn't be applied to all regions and further research is needed. Just as discussed above and shown in many documents, public participation has caused and is causing particular attention. As for the issue of public participation, Luo et al. (2007) focused on investigating into its necessity, its status quo and current problems. With this in mind, further details and different ideas about public participation will be presented based on the investigation.

5.1.3 SEA for Water Management Policies

No such efforts have been made. However, to an extent many environmental issues are directly or indirectly related to water-associated policies.

In general, water policies, regulations and ordinances, such as Incentive Policy for SHP (Small Hydropower Planning), Water Conservancy Industrial Policy and Water Resources Policy provide macroscopical guidelines for the development of water conservancy and the management of water resources. Whilst there have been some successes in some aspects of their implementation, it is disappointing that there have been and are still some potential large-scale environmental negative impacts. In this regard, the negative impacts of Incentive Policy for SHP and the role of SEA for it will be discussed in detail.

The development of mini and micro hydropower projects in China's countryside is mainly under the support of the governments of various levels, who established a series of small hydropower policies. These policies focus on economic incentive policies, based on Planning Economy, and many preferential policies have been adopted for encouraging private capital to participate in the construction of small hydropower stations. These policies promote the upsurge of rural mini and micro hydropower, for changing the nationwide severe status of insufficient electric supply.

Theoretically, small hydropower projects offer emission-free power solutions for many remote communities, such as the rural ones in Southwest China, and are free from many of the environmental impacts, because they use the natural flow of the rivers and thus produce relatively little change in the river channel and flow (Nachman-Hunt, 2001). However, de facto, the prevalent construction and out-of-order development of SHP have caused ecological disasters in rural areas of

Southwest China, due to lacking the comprehensive planning for water resources. The main ecological and environmental issues caused by the disorderly development of SPH include river channel shrinkage, dry river sections, water and soil loss, and destruction of aquatic eco-systems and so on. In addition, the impacts of SHP on the ecological environments are often extensive, long-term and irreversible. The root is that SEA fails to be integrated into Incentive Policy for SHP, and the negative environmental potentials fails to be considered during the decision-making process. Therefore, it is necessary to combine Incentive Policy for SHP with the integrated watershed plan, integrate SEA into the policy-making and planning processes at their early stages, in order to avoid the ecological crisis associated with unreasoning SHPs and meet the environmental objectives in the watersheds. Thus, Incentive Policy for SHP provides exact requirements for careful watershed planning processes and pays attention to regulatory and permit requirements, considering the cumulative environmental effects of all SHPs in the whole watershed, based on the SEA outputs during the policy-making process.

5.1.4 Brief Summary

This section focuses on analyzing the previous and current EIA cases for watershed management. EIAs for integrated watershed plans and watershed hydropower plans are the main types of watershed-PEIAs. That's why they will be selected for case study. For the ongoing revision of integrated watershed plans, the cases of the Yangtze River and the Jiulong River respectively represent the Major Seven Watersheds and the small-scale one at provincial level. As for the single-purpose watershed plans, the watershed-PEIA for hydropower has received comparatively more concerns both in practices and researches.

Moreover, no efforts have been made for EIAs of policies, although many environmental issues are directly or indirectly related to water-associated policies, such as Incentive Policy for SHP.

5.2 Questionnaire and Interview

The above analyses show the practical efforts for watershed-PEIAs. However, few available documents and research articles could provide us enough information for learning the status of watershed-PEIAs in China. Therefore, investigation by questionnaire and interview is necessary for further understanding the problems, obstacles, challenges and others in current watershed-PEIAs.

The questionnaire and interview were undertaken from February, 2009 to October, 2009, for further understanding the status of watershed-PEIAs and obtaining comments of improving watershed-PEIAs. Two rounds of questionnaire were conducted and the questions were distributed by paper questionnaire, emails, and web questionnaire.

Before the investigation, no document provided who had related experiences and knowledge of watershed-PEIAs for going on this study. Therefore, the question papers in the first round were distributed to all the general EIA participants during the period of China Strategic Environmental Assessment Forum in February 2009 and the first round aims to inform us the preliminary information about watershed-PEIAs, provide reference for further investigations and researches, and obtain the associated documents from them if possible. In addition, the questions need to be redesigned for further investigation and, accordingly, those without enough responses are deleted.

Based on the outputs from the first round, the focused groups in further investigation should be water-related agencies and qualified PEIA agencies. The water-related agencies with such experiences and knowledge mainly include EIA agencies in Fujian, Research Institutes of water resources under the control of the Major Seven Watershed Commissions, and water conservancy and hydropower agencies. The qualified PEIA agencies are increasing, and only a small part of these PEIA agencies, only those covering water-related management, may have participated in watershed-PEIAs or have examined them. Moreover, at present, the finished and ongoing watershed-PEIA cases could be categorized into three classes: those for the Major Seven Watersheds under the framework of nationwide revision of integrated watershed plans, provincial watershed-PEIAs for assisting the cases in the Major Seven Watersheds and advancing their regional water resources management, especially in Fujian, and those for hydropower planning in Southwestern China. Therefore, the second round focused on the persons in the following agencies: Research Institutes of water resources under the control of the Major Seven Watershed Commissions, water conservancy and hydropower agencies, qualified PEIA agencies covering water management, and the main responsible agencies for watershed-PEIAs in Fujiang. However, part of them may have only practices of managing water resources in an administrative region, rather than in a watershed. In addition, not all the people in the above agencies have truly participated in watershed-PEIAs. Thus, based on the first-round questionnaire, literature study and further document analysis, those with actual experiences of watershed-PEIAs and their contact information were identified and the question papers are mainly distributed to them. Besides the focused population, 300 question papers were also sent to those with general EIA experiences in qualified PEIA agencies and distributed in the following websites 'www.eiafans.com' (http://www.eiafans.com/x-space/html/97/t-36497.html;) and 'shuigong.com' (http://www.shuigong.com/FORUM/viewthread.php?tid=110149), for comments from those having knowledge of watershed-PEIAs despite having no such experiences.

Some differences exist between the two rounds of questionnaire, which are to be mentioned and considered in Sub-section 5.2.1. The supplementary interviews mainly focus on those questions in the second-round questionnaire, and several additional ones were also involved as reinforcements to those in questionnaire. Interviews 'can help to dig out information that might be neglected in questionnaire survey' (Lu, 2006).

5.2.1 Development of the Questions and Focus Groups

The main objective of questionnaire and interviews is to examine whether SEAs have been properly applied in China's watershed management. Specifically, the following issues associated with the theme in question are to be addressed: necessity of implementing PEIA in watershed management, produced documents in their watershed-PEIA cases, main limitations and measures for effective watershed-PEIAs, associated research suggestions or focuses. Effectiveness of current watershed-PEIA cases will also be identified.

(1) The First Round-Questionnaire

Both the occupations and their EIA experiences of the respondents influence their responses. The first round of questionnaire was conducted during the period of China Strategic Environmental Assessment Forum in February, 2009. This questionnaire is not specific to watershed-PEIAs and associated contents with this research are limited. However, the outputs are still beneficial to the study in some sense, especially providing references for developing questions in the second-round questionnaire. In the first round, 65 copies of the total 83 responses are effective for the questions about watershed-PEIAs in China. Among the effective ones, 11 respondents have participated in SEA practices during the watershed planning processes, of whom, only three are not from water resources institutions. Two of these three ones respectively come from two qualified PEIA agencies, and one is a government officer. Those without such knowledge mainly focus on answering the questions about necessity and effectiveness. Therefore, the second round of questionnaire focused on those in water resources agencies and the qualified PEIA agencies, especially those PEIA agencies covering water-related plans.

According to their responses, the questions were redesigned for further investigation. Those questions which most of the respondents are not familiar with were deleted and no details need to be provided here. For the multiple questions, such as Q3, Q15 and Q17, they were respectively followed by one question about the respondent's preferential one for avoiding no priority among their selected options. Moreover, additional questions in the second round were designed, such as those about CEA, the time of integrating PEIA into the watershed-planning process, the PEIA outputs, alternatives, public participation, the way of choosing the responsible SEA agencies and the responsible agencies at each main SEA stage, all of which may influence the effective watershed-PEIA implementation in some sense. As for Q19, it is included in both of the questionnaires. Due to revision of the questions, the responses from the first round were hardly considered, except the questions such as Q19. Therefore, the questions in the first round are not to be detailed in the following section.

(2) The Second Round-Questionnaire

The questions in the second round are as shown below, which are to be discussed as a core consideration in the research. The email-addresses of the EIA people in the qualified PEIA agencies, especially those likely having watershed-PEIA experiences, were obtained from the online information. In addition, the authors of the journal articles associated with watershed-PEIAs were also the trageted people to be consulted. Further, the 11 respondents with watershed-PEIA knowledge in the first-round questionnaire also received the question papers by email.

Q1 and Q2 aim to understand the attitudes of EIA practitioners about necessity of watershed-PEIAs. Generally, there is a chapter about water resources protection, or water quality protection or water and soil conservation in the watershed plan report. 'Does this chapter conflict with the watershed-PEIA?' needs to be answered, which helps to answer Q2 'is it necessary to apply SEA in watershed planning'.

Q3 and Q4 refer to the documents produced in the watershed-PEIAs, which the respondent is familiar with. Any of the following documents is necessary for a successful EIA: the preliminary preparation report, the preliminary report of the environmental baseline, the framework for EIA, the detailed technical report for

CEA, the report about public participation and consultation, the monitoring and follow-up report, as well as a separate EIA report or an EIA chapter. However, in some cases, there is even neither a detailed EIA report nor an EIA chapter, not to mention other documents, especially those associated with public participation and follow-up.

Q5 relates to CEA, which has been recognized as a necessary part of SEA. It has not received its deserved attention in many cases. Q5 aims to examine whether or not CEA was properly addressed in watershed-PEIAs.

Q6 deals with the consideration of alternatives when applying SEA in watershed planning processes. 'No no-development alternative and other alternatives, except the proposal under study, are fully considered', which connives the approval of the planning proposal without taking account of the environmental consequences in some sense.

Q7 touches the extent to which the PEIA outputs was accepted to be integrated into the decision-making process. Even though the PEIA outputs have been obtained by sound procedures and methods, it is in vain if they are not effectively integrated into the decision.

The early integration of SEA into decision-making process is the precondition of its effective implementation. Q8 intends to understand the time of integrating SEA into watershed management.

Q9, Q10, Q11, Q12 and Q13 were developed about public participation, which has been one focus influencing SEA performance in many decades. What aspects of the watershed-PEIA process did participants participate in? Who participated in the watershed-PEIA process? To what extent did their responses be accepted by the decision-makers and the EIA agencies? What are the main barriers of limiting the effective implementation of watershed-PEIAs? All those questions are used for evaluating the status of public participation in watershed-PEIA.

Q14 treats of the ways how to select the responsible PEIA agency, including 'bidding', 'appointing by the planning agency or by the environmental agency', or 'self-assessment of the planning agency'. The ways show different extents of equity or transparency when selecting the responsible agency and also influence the PEIA process and the final outputs.

Q15 and Q16 mention the main limitations of applying SEA in watershed planning processes. The final objective is to find the solutions for overcoming them, rather than only to identify them. Thus, Q17 and Q18 were designed for analyzing the research priorities at present, in order to improve SEA specific to China's watershed management contexts in the abstract and also in practice.

Q19 are used to show the attitude of each respondent on the effectiveness of watershed-PEIA. The responses to all the above questions help to explain the performance and effectiveness. In addition, the involved agencies also influence the effectiveness, so Q20 is designed to identify the agencies responsible for each stage of applying SEA.

Moreover, two open questions (Q21, 22) were designed for more information. These questions are expected to provide some cases and some suggestions for the study.

During the first round, the questionnaire mainly focused on the EIA people in various agencies. Based on the respondents' ideas, focus groups in the second round and in the interview include those EIA experts in watershed management agencies and qualified PEIA agencies, especially the senior ones with rich watershed-PEIA experiences.

(3) Interviews

The questions for interviews are similar to those in the second-round questionnaire, with some changes. During collecting the data from July 2008 to October 2009 and during the period of The China Strategic Environmental Assement Forum, Feb 2009, Hong Kong, non-structured interviews were conducted by casual talks centering on watershed-PEIAs.

As for structured interviews, they were undertaken from July to October, 2009. The focused groups include the EIA people responsible for SEAs of watershed hydropower plans in Southwest China, SEAs of integrated watershed plans of the Major Seven Rivers, and SEAs of integrated watershed plans in Fujian.

5.2.2 Description of the Respondents

Tab 5.1 Respondents in the Second Round of Questionnaire Survey

No. of Respondents	21	23	4
EIA experiences	Y (>10 years)	Y (<10 years)	N (< 1 year)
No. of Respondents	32	16	
SEA experiences for watershed planning	Y	N	

As mentioned above, the respondents and the interviewees mainly come from water-related agencies and qualified planning-EIA agencies, especially those covering water-related plans, because the research topic is still new to many EIA people, even though they may be armed with PEIA experiences in other sectors and project-EIAs. Totally 48 respondents include 4 from the network investigation, and 13 from the general EIA agencies, besides those from the focused population. Among these 48 respondents, only 4 have never participated in the EIA process, and 21 ones of the left 44 have EIA experiences of even more than 10 years. Of particular note, 32 have watershed-PEIA experiences, one of them even having helped drafting *Regulation for EIA of Watershed Plans (SL45-2006)*, and others have associated information by examining or approving such SEA cases or other ways (Tab.5.1). Those beyond the focused population mainly come from the EIA agencies and environmental research institutes, only a small portion of them having such knowledge or experiences. People who didn't reply may include those with the left-off email addresses, EIA people being strange with watershed-PEIAs, and some reluctant to help the research.

Despite its small number of the respondents, the questionnaires are still effective and representative for the study. The respondents' occupations have involved most of the main agencies relating to the past watershed-PEIA efforts in China: the main watershed committees, water conservancy and hydropower companies, the EIA institutes in universities, and those involved in the watershed-PEIA series in Fujian and their responses have covered most of the Major Seven Watersheds in China and other past associated cases. In addition, only an extremely small portion of EIA actors have such knowledge and experiences. Therefore, the responses from the second round questionnaire can explain the status of watershed-PEIAs in China, together with the interviews and case analyses. The comments from those with watershed-PEIA experiences are particular help for the research. Their responses have covered the cases of the Major Seven Watersheds and those associated with the ongoing nationwide revision of integrated watershed plans, which include watersheds of various scales from the Major Rivers to the small Rivers (integrated or specific planning processes).

The interviews were undertaken as a supplement for the questionnaire. Totally 18 respondents gave their comments, in structured or non-structured interviews. The questions were centered on the questions in the questionnaire, but additional information was also desired.

5.2.3 Analyzing the Investigation Outputs

Responses from the first round are not to be discussed in detail, except little useful information (such as Q3 and Q19, with no revision between the first and second round). In this section, unless otherwise indicated herein, all the responses are from the second round.

(1) The Necessity of Watershed-PEIAs

Tab. 5.2 Responses about the Necessity of Watershed-PEIAs

		Responses			
Q1	Does this chapter conflict with the EIA about watershed planning?	Y	N	Null	others
		0 (*16*)	45 (*48*)	1(*1*)	2
Q2	Is it necessary to apply SEA in watershed planning?	Highly necessary	Necessary	Unnecessary	No idea
		29 (*60*)	18 (*4*)	1 (*1*)	0

* The numbers in the brackets show the responses from the first round.

Before the systematic investigation, an expert from a watershed agency (B3) mentioned that 'there are strong overlays between watershed-PEIAs and the part about environmental protection in watersheds planning reports'; therefore, 'it is unnecessary to conduct SEA in the watershed planning process'. However, 46 respondents about 'Q1' acknowledged 'no overlays exist between watershed-PEIAs and the environmental part in watershed plans because they have different focuses.' Among them, one expert (A22) also recommended their combination for improving sustainable watershed developments. In the first round, 9 ones, among the 16 respondents with a positive answer, have an opinion of slight overlays (the questionnaire outputs indicate that 98% of all the respondents don't think that there are overplays between watershed-PEIAs and the part about environmental protection in watershed-plan reports.) Moreover, an EIA expert with 25-year experiences think part of them overlay, but both are necessary.

As for Q2, only one has a negative attitude. Among the left 47 ones, 29 ones highly agreed with the necessity of watershed-PEIAs (in the 1st round, 94% of those respondents acknowledge the necessity of watershed-PEIAs.). The respondents include those from watershed agencies and EIA agencies, which have no distinct division and part of which have both roles of water management and EIA. Indeed, the rationale for applying SEA in watershed management has been discussed in the literature review of Chapter 2. In addition, when the respondents deny 'the overlap' in Q1, they may imply that SEA and the environmental chapter play different roles and can coordinate smoothly for sustainable watershed management in some sense.

(2) The EIA Documents for Watershed Plans

Four of the 48 responses are null and void for Q3 and Q4. In addition, one didn't choose any option, who thought 'technical details, public consultation and follow-up are generally included in the PEIA reports (especially after 2006), but no such details or none of them in the EIA chapter'. Further, 6 people mentioned 'there is neither the EIA report nor one EIA chapter' in their familiar cases, three of whom noted 'their cases have no any of the listed documents'. Thus, the left 37 noted 'their cases have the EIA report or the EIA chapter in the watershed plan'.

Besides the EIA report or the EIA chapter, all the documents in Q4 are necessary references for follow-up, monitoring and examination. Preliminary report on environmental baseline, technical report and report on public participation are comparatively more common in the watershed planning cases, based on the investigation. However, the contents and the extent to which the public's comments were adopted are questionable. In addition, none of the responses has included all the listed documents in Q4 and the produced documents are almost entirely different in each case or in the different versions of the same watershed's plan; none of the listed necessary documents has been included in all the cases that the respondents are familiar with (Tab. 5.3), which shows the confused SEA standards and requirements during watershed planning. There are still different regulations for integrated plans and specific plans even in *Ordinance of PEIA*; the applying scopes of the watershed-PEIA report and the EIA chapter in the watershed plan report are not clear.

Tab. 5.3 Responses about the Produced Documents

Type of EIA documents		No of responses
A.	EIA report	26 (*27*)
B.	EIA chapter	11 (*31*)
C.	Neither the report nor the chapter	6 (*5*)
D.	Preparatory report	5 (*11*)
E.	Preliminary report on environmental baseline	12 (*21*)
F.	EIA framework	9 (*20*)
G.	Detailed EIA technical report	16 (*19*)
H.	Report on public consultations	18 (*18*)
I.	Follow-up and monitoring report	7 (*13*)
J.	No other document besides EIA report and chapter	*17(14)*

* The numbers in the brackets show the responses from the first round.

Moreover, several respondents gave some ideas beyond the questions. For example, there are no documents, but the EIA people have investigated the associated persons in the studying watershed, the environmental protection agencies, EIA technical agencies and taken notes about their comments for EIA; only an EIA report without other documents is involved in the 2007 hydropower planning cases of Fujian, due to the limited time and funds.

(3) Consideration of CEA, Alternatives and EIA outputs in Watershed-PEIAs

Totally 32 respondents gave valid answers about 'CEA'. Only 2 ones said CEAs are not touched in their cases. This shows that, in China, most EIA people have realized the importance of CEA when undertaking watershed planning and its associated PEIA. However, only 2 ones indicated that cumulative effects had been systematically analyzed in their familiar cases. Moreover, more than half of the respondents showed that cumulative effects were just simply mentioned or even not touched in the cases they were familiar with. Lack of systematic CEA may be attributable to two aspects: lacking advanced methods and technologies for CEA, and lacking political supports because the environmental management agencies under the control of their corresponding governments still tend to adopt quantitative or semi-quantitative outputs of the project-EIAs, rather than the qualitative CEA results for easier management.

Tab. 5.4 Responses about Consideration of CEA, Alternatives and EIA outputs

	Options	Number	Total number
CEA	Y, systematic	2	32
	Y, partly	13	
	Y, simply	15	
	N	2	
Alternatives	Y, with 'no-development' plan	29	47
	Y, without 'no-development' plan	11	
	N	7	
EIA outputs	Totally	4	49 (1 having two responses)
	Partly	30	
	Seldom	5	

	Not at all	2	
	Not clear	8	

As for 'alternatives', 85 percent of the 47 responses choose the 'positive' options. That implies the generally acknowledged significance of 'alternatives' in this field of China. In addition, more than half mentioned that their familiar cases had considered the environmental trends without the proposed plan, together with the environmental implications of one other alternative or more. However, in practice, none of such cases have adopted '0' plan in its final decision, which could be reflected by the comments from the interviews below. Moreover, some cases had no any alternatives, even in the new version of Integrated Watershed Plan of the Huai River.

One respondent has two answers for the question 'Q7', because he has rich experiences of watershed-based EIAs and each case may has different assessing processes and schedules. 70 percent of the responses show that most cases have considered the EIA outputs, partly or totally.

However, if the integration is too late, the EIA outputs could hardly be used for improving the plan and mitigating the negative consequences. In addition, less advanced technologies and less qualified EIA persons may lead to inaccurate prediction and assessment of environmental implications. Thus, even the EIA outputs have been totally integrated into the planning process, the implementation of EIA is not satisfactory.

(4) Time of Integrating SEA into Watershed Planning

Three respondents have more than one answer for Q8, each answer being specific to various cases which they get acquainted with. In addition, 2 respondents didn't reply to it. Thus 50 responses are obtained. Only 5 responses, 10 percent, realized the early integration of SEA into the planning process. In addition, it is after the draft plans were developed or before the plans were submitted for examination and approval that 56 percent of the cases begun the EIA process, when the planning objectives had been decided without fully analyzing key environmental issues and the planning contents had been partly established. These EIAs mainly aimed to reflect the environmental consequences, rather than make an environmental-friendly decision. Moreover, the EIA efforts in the course of planning could be categorized into two types: one integrating EIA into the whole planning process and one linking EIA with part of the plan. The former could fully assess and analyze the environmental implications of each alternative for environmentally positive planning; the latter could only integrate environmental considerations into part of the planning process or of the planning contents. Here, the 17 responses are not easily divided into such two distinct types.

Tab. 5.5 Time of Integrating SEA into Watershed Planning

	A	B	C	D	
Stages	Early in the planning	In the process of planning	When having a draft plan	Before examination and approval	Total
Number	5	17	18	10	50

(5) Public Participation

Tab. 5.6 Involved Public Participants

Participants	Experts	Affected individuals	NGOs	Government agencies
Number	26	29	3	29

Tab. 5.7 Participatory Aspects of the Public

Participatory Aspects	Survey on Environmental baseline	Identifying environmental effects	EIA indicator determination	Mitigation measures	EIA Conclusions & Reports	Follow-up & monitoring	Others
Number	23	19	4	18	20	4	7

Tab. 5.9 Elements Limiting Public Participation

Limitations	A: Limited Information openness	B: Participatory system	C: Public capacity	.D: high professional requirements	E: Improper participatory ways	F: Others
No of respondents	27	28	31	17	11	7

Theoretically public consultations should be involved through the whole planning and EIA process; all the aspects relevant to the listed options should be consulted with the public: 'investigation of environmental baseline', 'identification of environmental implications', 'identification of EA indicators', 'mitigation measures', 'EA results and its report', and 'follow-up and monitoring'. However, as shown in Tab. 5.7, no one option has been covered by all responses. Moreover, only in two responses, all the listed aspects have been covered by public participation, which implies that not all stages of the EIA process involved the public participation in most cases.

Five respondents ticked 'others' without other selection and without instructions on 'others', which implies that public participation plays a role in other aspects of their cases to some extent, rather than the listed aspects. Two respondents ticked 'others' without explanations of 'others' but with other selections, which means that public participation plays a role in other aspects of their cases to some extent, besides part of the listed aspects. The additional comments beyond the listed options about public participation are summarized as follows.

Firstly, public participation was not always involved in watershed-PEIAs (A18; A28). Secondly, in some cases, none of the listed aspects involved the public participation and the public only showed their attitude whether they would accept the proposed plan or not, and the issues of their own interests (A37; A42). Thirdly, objectives of the watershed plan, coordination with other plans, its key environmental potentials and mitigation measures, as well as all the listed aspects, were also consulted with the associated agencies and individuals. Fourthly, 'few public are familiar with the planning process and the EIA, so public participation often becomes a mere formality and has little help to the EIA process' (A26).

As for the involved public, only 29 responses mentioned 'individual stakeholder'. That's to say that experts and government officers are the main body of the involved public, which is also reflected in the interviews.

There are 33 responses available for Q11, 12. Based on Tab.5.8, public opinions are partly considered in most responses. However, 'generally few public advices are obtained, or even no comment from the public' (A27). In addition, no explanation for those public comments without being considered was provided in all cases.

Tab. 5.8 Disposal of Public Opinions

Disposal of public opinions	Totally	Partly	Seldom	No at all	No idea
	3	23	1	0	5

All the listed factors received some concerns from the respondents, especially public capacity, limited information openness and the imperfect participatory system (Tab. 5.9). In water sector, information openness is more seriously limited, due to the high confidentiality of many data relating to watershed plans and water resources (A23). As A23 noted, 'the data associated with watershed plans are limited to be open to the associated agencies, not to speak of the general public, due to the high secrecy of part data'. A42 also emphasized the significance of improving information openness, who noted that 'generally the planning contents are seldom published or only the brief introductions were provided if possible'. In addition, the general public and government officers in the associated agencies have great difficulties in fully understanding the problems associated with watershed plans and their comments are often based on their own interests, individual or sectoral, due to their narrow knowledge and illiberal views.' 'Low public capacity' and 'lacking environmental awareness' may be the mirror of 'poor national education and uneven education levels'. Also, an expert from a water resources management agency (A6) realized the importance of public awareness and cognition for environmental issues, especially emphasizing the cultivation of environmental awareness and propagating environmental knowledge. High professional requirements of watershed management and its SEA process, together with the limited capacity of the general public and 'lacking social culture and safeguard for ensuring speak- one's-mind-freely' may also lead to few comments or useless ones from the general public. In addition, 'high uncertainties of the environmental potential consequences of the proposed projects during the planning period may lead to the confusions of the public' (A40). Moreover, participatory ways should be selected relying on the planning objective, the characteristics of the watershed as a whole and its various parts, the general education levels in each part, the participatory stage and aspect, rather than be invariable for all watershed plans, and across the whole watershed and through the whole planning process.

Despite the various limitations, including the above and others, it is above all else that the planning agencies and other responsible agencies are unwilling to undertake public participation (A2). Generally, lacking political and institutional willingness often tends to make public participation as a mere formality.

(6) Selection of Responsible EIA Agencies

Tab.5.10 Responses about How to Select Responsible EIA Agencies

Bidding	15
Being designated by the planning agency	14
Self-assessment of the planning agency	3
Being designated by the environmental agency	7
Others	10

One null response exists for this question and one respondent gave two options: 'bidding' and 'being designated by the planning agency'. Based on the statistics, 'bidding' and 'being designated by the planning agency' have higher proportions. However, the EIA agency designated by the planning agency often has some close relationship with the planning one. An implied contract exists between them, aiming to make the EIA document and the plan approved. Moreover, the 'bidding' way, with the help of Fund Trustee System, aims to avoid the EIA agency to make concessions to achieve the planning-agency's purpose for obtaining their deserved EIA funds. The current bidding system is not enough perfect to avoid the above problem (A10).

Besides the listed ways, several other ones were also mentioned by some experts. 'The planning agency may select or designate a agency responsible for environmental assessment by negotiating with the environmental protection agency, water conservancy and others' (A2; A42; A10), or 'the management agency is responsible for selecting one from the qualified PEIA agencies (A9)', besides the way of 'being designated by environmental agency'. In water sector, the management agencies include water administrative departments of various levels, such as Ministry of Water Resources with its subordinate watershed management commissions and water resources departments or bureaus in provinces and counties. Two experts (A22 and A33) mentioned that it is the construction agencies or development agencies involved in the watershed plan that chooses the responsible PEIA agency in some cases. This phenomenon is common in watershed hydropower plan. Moreover, it is also noted that the selection of the responsible EIA agency is generally determined by the execution agency of the plan, such as the local government or watershed development Company (A22, A25). Moreover, Provincial Development and Reform Commission of various levels is an important authority, which in some cases are responsible for designating the EIA agency; that's common in provincial or smaller watersheds (A43, A45).

(7) Main Limitations of Watershed-PEIAs and Research Priority

All of the listed obstacles have hindered and will hinder the SEA performance in a long period, of which *'Lacking theoretical researches about watershed-PEIAs'*, *'Inadequate management system of water resources and water environments'*, *'Too* *short time for EIA to fully analyze the environmental effects', 'Lacking clear and unambiguous guidelines for watershed-PEIA', 'Decision-making backgrounds including political, economic and cultural contexts'* are of more concerns, either when more than one choices were selected or when a single answer was selected from the above options. Among these factors receiving more attention, *'Lacking theoretical researches about watershed-PEIAs', 'inadequate management system of water resources and water environments', and 'Lacking clear and unambiguous guidelines for watershed-PEIA',* are specific to watershed management. The responses are analyzed as follows.

'The one above all else is the decision-making process, which is difficult to be addressed in a short period,' (A42) and 'supports from the decision-making agencies play key roles in the effective SEA of watershed management' (A2; A37). In addition, 'information, such as that about pollution sources, productive ways and industrial profit level information, is not enough for watershed-PEIAs' (A16). Moreover, 'it is impossible to conduct a widespread investigation and fully identify the environmental implications, due to the restraints of time and funds' (A47). Further, various sectors are often involved in watershed management and, due to the lagged intervention of EIA, many accomplished facts often influence the effectiveness of watershed-PEIAs (A10), which is also a consequence of the listed factors. Finally, 'lacking follow-up assessment' was also mentioned as a barrier for all kinds of SEAs, which in fact falls under the purview of '*Lacking clear and unambiguous guidelines for watershed-PEIA*' and *'Unsound laws and regulations about watershed-PEIAs'* (A17).

To overcome the above limitations is not a business that can be done in a day. As a researcher, what he can do is to conduct associated researches for providing references. What may be the future research focuses and priorities have been provided based on the responses to Q17 and 18. All the listed research topics, including researches about IWM (integrated watershed management), water resources management system, decision-making backgrounds, CEA methods, environmental carrying capacity, framework and indicators of watershed-PEIAs, prediction methods of environmental implications of watershed developments, legislation associated with watershed-PEIAs and uncertainties in watershed-PEIAs, received more or less concerns of the respondents. Only researches about decision-making backgrounds and legislation obtain few concerns. Besides the listed research themes, '*researches about the current issues in watershed developments, China*' was also mentioned (A10).

Although all the listed options received some concerns and lots of efforts need to be made for the associated researches, only a small portion is being systematically conducted at present or will be systematically conducted in the near future. Here only the framework of watershed-PEIAs and its indicator system are to be discussed in depth, which will lay a foundation for future researches on other topics.

(8) Effectiveness of Watershed-based PEIAs

Tab 5.11 Effectiveness of Watershed-based PEIAs

	The 1st	The 2nd
	Number of the respondents	Number of the respondents
Effective to a great extent	4	1
Effective to some extent	36	30
Effective only to a small extent	19	12
Not effective	0	2
No idea	5	3

Most of the respondents in the first and second rounds didn't think past watershed-based PEIAs effective to a great extent. However, most of them recognized the effectiveness of watershed-PEIAs, anyway, which brings a ray of hope to the future.

(9) Open Questions for More Information

For open questions, some cases and associated comments were provided. The cases mainly focus on the following aspects: Integrated Watershed Plans in Fujian and the Major Seven Watersheds under the nationwide revision framework, specific watershed plans associated with the revision of the integrated ones and several earlier ones. These cases could be adopted for analyzing the status, especially about the technical arrangements and their performance.

As for the recommendations from the respondents, the details are presented as follows. Beside the overriding concerns on CEA and other EIA methods, they also mentioned the importance of developing guidelines and strengthening the legislation. For developing directive guidelines, the general framework and its indicator system need to be built as references for all watershed-PEIAs, although they should be altered based on the specific nature of the involved watershed, the objectives and other attributes of each watershed plan. Coordination between various sectors involved in watershed management is also noted as a difficulty in watershed-PEIAs, due to their extremely intricate relationships. Moreover, the EIA agency, the sharing of associated experiences and researches, researches about integrate watershed management and decision-making backgrounds, differences between integrated and specific watershed plans, the enforcement of the EIA law and regulations, and 'government interventions' need be concerned. All these have influenced the effectiveness of SEA for watershed planning, part of which has been reflected in the multiple questions of questionnaire paper.

5.2.4 Responses from the Interviews

According to the interviews with the officers and experts in water sector and SEA agencies, the main characters and challenges in watershed-PEIA practices are as follows. The interviews could be categorized into structured and non-structured ones.

(1) Structured:

Structured interviews mainly focus on three areas: SEA for the integrated watershed plan of the Hai River representing Nationwide Revision of Integrated Watershed Plans, SEAs for integrated watershed plans in Fujian, and SEA for hydropower plans in Southwest China. Under the framework of Nationwide Revision of Integrated Watershed Plan, all the Major Seven Watersheds follow the similar technical framework and associated SEA efforts have undergone similar procedures, despite some differences in their details. Therefore, only one watershed, the Hai River, was selected for interviews, and respondents from other watershed agencies have expressed their comments in the questionnaire. Southwest China plays a lead in hydropower planning of the whole nation, and associated SEAs for watershed hydropower plans are also in the lead. Interviewees from the MEP (Ministry of Environmental Protection), PRC, were also consulted for expecting their comments.

During the interviews, the following aspects were presented for comments: necessity of watershed-PEIAs, the familiar watershed-PEIA cases, CEAs, public participation the main limitations in current watershed-PEIAs and the priorities for overcoming them, the difference before and after The 2003 EIA Law. The details of the involved questions are listed in Appendix IV. Moreover, more information beyond the questions was provided by the interviewees.

When conducting the structured interviews in the EIA agencies associated with the above three areas, many EIA experts, even those with rich experiences, have no knowledge about watershed-PEIAs (B11; B12; B15; B19). Only an extreme small part of their colleagues, who have participated in, or examined or approved such cases, especially some senior leaders with high seniority, can provide such information about watershed-PEIAs (B11; B12; B15; B16; B19). The comments from the interviewees were shown in detail in Appendix V, which are to be discussed based on the following topics: information openness, public participation, CEA, main institutional obstacles and recommendations for PEIAs of integrated watershed plans.

1) Information openness

The associated documents are not open. Even he who has taken part in the SEA process can only obtain part of the documents relating to his part (B7). When conducting interviews, few of them are willing to provide the associated documents for some reasons. For example, no other details about the Hai River Basin were provided besides the catalogue of the EIA chapter and the matrix table for environmental prediction (B8). Moreover, when conducting the watershed-PEIAs, many data need to be obtained by field monitoring or by purchasing from the associated agencies (B13). Especially the latter way is more preferred, because the data from the government agencies are easier for comparing (B13).

2) Public participation

In many cases, the involved public mainly focuses on the representatives from the government agencies and research institutes: officers, experts and scholars associated with the plan, rather than the general public (B8; B16; B23). The general public and stakeholders seldom participate in the watershed planning process and associated PEIAs. Even they participate in the watershed-PEIAs, their comments are seldom considered. The following reasons for unsatisfactory public involvements were mentioned by the interviewees.

For watershed plans and the associated PEIAs, the general public does not possess the basic knowledge. In some cases, even the EIA experts have not thorough understanding of that, due to uncertainty of the involved projects and their locations, scales, and numbers, not to mention the general public (B9). In countryside, public participation activities are often organized by the local villagers committees. The EIA people distribute the question papers to the villagers and take a long time to explain the questions to them, because most of the villagers can't understand them and even some are illiterate (B10). Moreover, the farmers concern more on living, occupations, and compensation for damaging cultivated land, houses and irrigation, rather than the environmental trends (B10; B16). The public with primary and senior school education has more concerns on the environments, noise and dust during the construction, than the illiterate (B10). On one hand, the planning agencies are unwilling to let the EIA agencies conduct public participation for avoiding the baffles from the public (B19); on the other hand, only the government's efforts are not enough and, public understanding and awareness also limit the general public to help make the watershed plan and its SEA process. Further, the opinions from the general public are not advisable, due to the above reasons (B16; B21).

3) CEA

The necessity of CEA has been recognized by the EIA experts (B8). However, the consideration of CEA is not satisfactory. In most cases, cumulative effects have not been fully considered (B9; B16; B21). Firstly, most of the planning agencies concern more on direct environmental implications, rather than indirect and cumulative effects for easier implementation (B8; B21). In addition, the current researches about CEA can't help define well the cumulative environmental effects, especially those on ecosystems and water environments (B10). Therefore, fundamental researches about CEA are necessary (B16). Moreover, limited funds and time are also responsible for its limited consideration (B8; B16).

For example, the case of the Jiulong River, which has been adopted as a model of watershed-PEIAs in Fujian, included 125 engineering projects with cumulative environmental potentials such as the declining sediment delivery to the estuary, the estuary to be eroded and so on. These effects may be irreversible and inestimable. However, the examiners preferred the environmental consequences of each individual project to the cumulative ones with more uncertainties, for easier management (B21).

4) Institutional and Legal Deficiencies

No efforts are exclusively made for examination of the watershed-PEIA results, until the 2003 EIA Law (B9). Moreover, several proposals about watershed hydropower plans have been rejected by providing enough explanations, or some proposed projects have been deleted from the plans, which is impossible before 2003 (B9; B10; B16). For watershed–PEIAs in China, many problems exist, although the government has given increasing attention to them (B10). Besides the limitations listed in the question paper, the interviewees expressed their own opinions.

At present, there are few successful watershed management plans, not to mention SEAs for such plans (B13). So-called 'Nine Dragons Governing the Water' is one main reason for failures in achieving effective watershed-PEIAs, which implies that nine or more government agencies are involved in water management of China. Moreover, the provincial environmental agency has no direct functional relationship with MEP (Ministry of Environmental Protection), PRC, which is under control of its associated provincial government (B19; B20). Thus, watershed plans and associated PEIAs in the small-scale provincial watersheds are, in fact, under the control of the provincial Development and Reform Commission or other government authorities, rather than MEP (Ministry of Environmental Protection), PRC (B19; B20). For watershed-PEIAs, they are directly under MWR (Ministry of Water Resources), PRC and local related agencies, especially before the 2003 EIA Law (B18). Therefore, the EIA report for integrated watershed plans in the Major Seven Watersheds need to be presented to MWR (Ministry of Water Resources) and be approved by the State Congress (B8). Further, some projects are building or have been decided to be built, when initiating the PEIA process or even proposing the plan, which is attributable to a top-down management style (B21; B22).

Due to the conflicting regulations about the final EIA document, whether to edit the EIA report often confuse the planning agencies and the involved EIA agencies (B8).

The result is that the EIA report is edited in one case, but only one EIA chapter in another similar case.

Self-assessment exists (B9). It is also attributable to the fact that EIA agencies are reluctant to be responsible for watershed-PEIAs due to limited funds and the planning agencies often take a stand of 'Money buys case and comfort', because of their thinking PEIAs unnecessary (B9), besides the institutional and legal deficiencies.

As for institutional and legal deficiencies explained above, they limit the implementation of watershed plans and watershed-PEIAs at source. For example, the Yellow River Commission, being as a stronger watershed management agency, is unable to harmonize the relationships between various sectors and various administrative regions, not to mention other watershed management agencies (B13). Even in the Tennessee Valley, Tennessee Valley Authority has difficulty in harmonizing its relationship with other watersheds (B13). The success of the Tennessee case lies in its special backgrounds whose pattern is not appropriate for other watersheds (B13).

In the Murray-Darling watershed, Australia provides a 3-tier administrative pattern for watershed-based water resources management (B13). However, this pattern still has difficulty in harmonizing the watershed-based integrated development, not to mention watershed management in the current institutional system in China (B13).

5) Technical Dimension

Institutional backgrounds determine the rights and powers of each group, and how to balance the conflicts between the groups is the knotty problem for integrated watershed management (B9). Therefore, they influence the adoption of the EIA results. At the same time, they also impact the PEIA process, indirectly influencing the EIA results. The PEIA process includes the time of integration into the planning process, the consideration of alternatives and the proposed EIA documents, which, together with the institutional arrangement, influences the EIA results.

Theoretically, the planning process and the PEIA should have synchronous schedules and the planning report should be drafted based on the EIA conclusions (B9). However, practically, most cases haven't achieved the synchronization of them and, in some cases, the watershed planning process was undertaken even just before the plan was implemented (B8; B9; B14).

The number of the produced documents often depends on the scale of the plan (B9). Some watershed-PEIA reports were edited by copying the contents in the associated documents or those in other similar cases (B9; B22).

The selection of alternatives is often decided by consulting with the planning agencies, rather than by comparing their EIA results (B9). Moreover, few 'no-development' alternatives have been adopted.

The EIA team also influenced the EIA process. The current EIA team is rather a mixed bunch of people with high or low capicity or responsibility. Comparatively, the EIA actors, who shoulder the responsibility in earnest, are often refused by the planning agencies, so that they have few opportunities for participating in watershed-PEIAs, for avoiding more cost- and time- expenses and for avoiding hindering the planning agency's economic interests (B9).

As discussed here, the technical dimension, such as time of SEA integrating into watershed management, selection of alternatives, and consideration of CEA are all influenced by the current institutions and legislations. That means institutional contexts and technical details are interacted to influence watershed-PEIAs.

6) Research Suggestions

At present, many EIA agencies, including those in colleges, universities, and institutes, seldom conduct associated researches, often commercialize EIAs merely for making money, and have mass-produced a batch of EIA reports (B19). There is little way out for the current researches about SEAs, all of which only give some general ideas and possess few academic values. In addition, from the international perspective, there is no profound research achievement (B21). As for the academic periodicals, articles about SEAs seldom appear in SCI periodicals. Only some articles of poor quality have been published in the periodical 'Environmental Impact Assessment Review'. Most research articles are superficial and scanty (B21). Besides the listed research focuses, the interviewees have given other suggestions.

For researches about watershed-PEIAs, a researcher with high seniority recommended that linking integrated watershed management with the current institutional reform in China is desirable for sustainable watershed management (B13). That is to say that the ideas about how to reform the watershed institutions for harmonizing the complex relationships in watershed management need to be researched under the ongoing national institutional reform. Although researches about the institutional limitations of implementing SEAs are none of academic significance (B21), they could be used to provide references for institutional reforms. In this research, nevertheless, suggestions for institutional reform of watershed management could be provided as part of the watershed-PEIA framework, but their actual achievements need political supports.

From the technical dimension, researches about general SEA methodologies count greatly, especially when case study is accompanied (B21). Moreover, linking GIS, RS technologies and watershed models is recommended for analyzing the cumulative environmental consequences (B20). For example, the GIS-based watershed model could be adopted for analyzing the impacts of constructing reservoirs on hydrological situations, pollution sources, hydrological ecosystems, and hydrological dynamics.

(2) Non-structured:

Besides the structured interviews, talks with experts and actors in environmental sector and water sector also provide associated views about watershed-PEIAs. Their views are summarized into the following aspects. Firstly, most of the general EIA actors have not participated in such practices, except an extremely small portion from the qualified PEIA agencies, especially those related to water and watershed management. Secondly, few successful cases have been found and little attention has been paid to relative researches. Thirdly, few specific techniques have been adopted for watershed-PEIAs. Fourthly, self-assessment exists in watershed planning agencies (B4; B6). Extreme difficulty exists for SEAs in water sector, which is also one reason of the EIA agencies being reluctant to conduct such cases and self-assessment is more common in water sector than in other sectors (B5).

5.3 Case Studies: Performance and Effectiveness

To go deep into understanding the practical application of watershed-PEIAs in China, particularly the technical details and the effectiveness of current watershed-PEIA efforts, case studies are adopted. At present, there are mainly three sets of such cases, which represent the current SEA efforts for watershed management in China. They are cases respectively associated with integrated watershed management in Fujian, the nation-wide revision of integrated watershed plans in the Major Seven Watersheds, hydropower plans in Southwest China and other regions. In Fujian, the case of the Jiulong River is selected for detailed analyses, which provides the references for other similar ones. The ongoing nation-wide revision efforts were required to refer to their respective previous practices. The case at the Estuary of the Yangtze, which has been listed in *Comments on SEA Cases* of the EPD (Environmental Protection Department), PRC, provides with some significant ideas about watershed-PEIA methods, especially about CEAs, (EPD, 2009, 2nd). Therefore, it was selected as a substitute of the case for integrated watershed plans of the Yangtze River, representing the cases of the Major Seven Watersheds. PEIAs for watershed hydropower plans have obtained concerns earlier than other types of single-purpose watershed plans and integrated watershed plans. The case in the Muli River was chosen for discussion in detail, which was provided in *Analyses on EIA Cases*, edited by the EIA center of EPD (Environmental Protection Department), PRC (2009).

5.3.1 Methods and Criteria Set of analyzing the cases

As discussed in Section 2.1.2, six aspects could be adopted for assessing the overall SEA performance: procedural effectiveness, substantive effectiveness, trans-active effectiveness, normal effectiveness, incremental effectiveness and the contextual effectiveness. In this part, available components of the above aspects are used for evaluating the selected cases.

Tab. 5.12 Components for Evaluating the PEIA Performance of the Selected Cases

	Components for evaluating PEIA performance
Procedural Effectiveness	Availability of data sources
	Time of integrating SEA into the watershed planning
	Technical soundness
	CEA
	Alternatives
	Follow-up and monitoring
	Public involvement
Substantive Effectiveness	Range of considerations of social ecological and healthy consequences
	Precise and verifiable predictions
	Mitigation measures

	Clear and understandable information and documents	
Trans-active Effectiveness	Time-benefit analysis	Integrating SEA into the decision-making process
		Taking mitigating measures
		Improving policies and laws
	Cost-benefit analysis	Integrating SEA into the decision-making process
		Taking mitigating measures
		Improving policies and laws
Normative Effectiveness	Sustainable development	
Incremental Effectiveness	Decision-making mindsets	
	Environmental Awareness	
	Participatory Cultures	
	Institutional Arrangements	
Contextual Effectiveness	Political, institutional, legal and cultural contexts	

Considering their availability and significance, only a small part of the involved components discussed in Section 2.1.2 were selected. The involved evaluation elements can only be explained in a qualitative manner, which are shown in Tab. 5.12.

5.3.2 Brief Illustration of the Three Cases

1) Case Set No. 1 in Fujian (the Jiulong River)

Watershed-PEIAs in Fujian have taken the lead across the whole nation. Most of the rivers in Fujian are not trans-provincial, and the relationships of various sectors are comparatively easy to be coordinated. However, that may more easily lead to the over-concentration of the provincial government's power in practical watershed management (comments from the respondents B19; B20). As for watershed-PEIAs, approximately more than 150 PEIA reports have been prepared for approximately 1000 watersheds, including 68 watersheds of more than 500km^2 (hereafter the large-scale ones) and 905 ones of less than 500km^2 (hereafter the small-scale ones). Here, the case for the Jiulong River will be analyzed in detail and its effectiveness will also be evaluated based on the above performance criteria.

2) Case Set No. 2 in China's Major Seven Watersheds (the Yangtze River)

Early in the 1950s, the first-round integrated river basin planning process began, mainly for overcoming serious floods and droughts and building water conservancy works. The existing watershed planning reports for the Major Seven watersheds were developed from the late 1980s to the early 1990s, based on those of the 1950s. In 2007, the third-round integrated watershed plans were initiated, due to the limitations of the current ones and even lack of watershed plans for some important rivers in South China and South-West China. Initiation of the revision efforts is mainly attributable to the problems in the active plans. They mainly include the following ones: outdated basic information; insufficient concerns on environments but more focuses on verification of major construction projects; inadequate contents about water resources allocation, water saving, water resources protection and management; requirement of harmonizing regional plans and integrated watershed plans; and integrated watershed plans lagging behind associated specific single-purpose watershed plans. The new versions of the plans focus on sustainable water resources utilization and watershed development, rather than verification of major engineering projects.

The nation-wide revision of integrated watershed plans was initiated in 2007; the revising tasks in the Major Seven Watersheds were expected to be finished in 3 years or so; and those for other important rivers were required to be finished in 5 years, mainly for satisfying both the current requirements of economic developments and environmental protection. The main objective is to sustain the health of the rivers and ensure sustainable utilization of water resources. The involved watersheds include the Major Seven Watersheds (including the Tai Lake Watershed), and the important trans-boundary (national or provincial boundaries) watersheds. Based on the technical arrangement of the planning process, EIA is required as an essential step. However, EIA is involved only after most of the planning efforts have been made, which was also indicated in the interviewing responses (B 8).

Comparatively, the case of the Yangtze River experienced an early integration of PEIA into integrated watershed plan. Nevertheless, it is still under way for the final approval and its documents are not available, except the planning scheme. Therefore, general arrangement will be discussed based on the nationwide scheme and the technical details will refer to the PEIA case at the estuary of the Yangtze River. On one hand, the case at the estuary of the Yangtze River has been cited in *Comments on SEA Cases* of the EPD (Environmental Protection Department), PRC (EPD, 2009, 2nd) as a good example. On the other hand, its responsible PEIA agency is Water Resources Protection Bureau, which also was responsible for the PEIA of integrated watershed plan of the whole Yangtze River. Further, its involved agencies and technical arrangements are similar to those of the integrated watershed plan.

3) Case Set No. 3 for Watershed Hydropower Plans (the Muli River)

Disorderly developments of hydropower stations in Southwest China have caused severe hidden dangers to the ecosystems. Associated watershed-PEIAs have been conducted in succession. Several hydropower projects have been laid on the table based on the PEIA results. At the same time, some projects have been initiated without approved project-EIA and PEIA. At present, watershed-PEIAs of hydropower plans have been an important part of current watershed-PEIA practices.

The Muli River is the largest tributary river in the middle reaches of the Yalong River. On one hand, local hydropower resources could not be fully utilized; on the other hand, firewood is still the main energy source for maintaining daily activities in rural areas. The original intention of developing hydropower stations in this watershed is to utilize hydropower resources, promote the economic developments and protect the watershed ecosystems, as the ecological barrier of the upper Yangtze River. In this hydropower plan, one reservoir and 6 cascades were involved. Associated agencies in Sichuan Province and two counties have participated in the planning process.

Watershed-PEIA for its hydropower plan was initiated in 2003 during the planning process. A subordinate agency of MWR (Ministry of Water Resources) at municipal level was responsible for editing the EIA report. Its technical details will be analyzed in Sub-section 5.3.3.

5.3.3 Analyses of the three cases (or Case Sets)

This subsection focuses on evaluating the performance of the above three cases. Before assessing their effectiveness, their overall arrangements and involved agencies will be introduced in brief, because they could influence the PEIA processes, the precision of the PEIA results and the implementation of the PEIA conclusions from the root.

'*Overall Effectiveness Criteria*' will be adopted for assessing the three cases and evaluating their performance. Procedural and substantial effectiveness will be the focuses of evaluating the three cases, and, other aspects will be also discussed if appropriate. Based on Tab. 5.12, the criteria for each aspect are as follows.

Actual environmental considerations, precise and verifiable predictions, mitigation measures and pellucid documents are used for evaluating substantive effectiveness of the three cases. They reflect the substantive and final results of the PEIA process.

Seven elements are adopted for evaluating their procedures: availability of data sources, time of integrating the PEIA into watershed planning, technical soundness, CEA, alternatives, follow-up and monitoring, public involvement. All of them reflect the PEIA effectiveness by influencing its results and its implementation, especially time of integration. Retrospective EA (environmental assessment), without timely integration of SEA into watershed plans, can't fully bring environmental considerations into the decision-making process.

For trans-active effectiveness, time and cost of integrating SEA into the decision-making process, taking mitigating measures and improving policies and laws need to be considered in the three cases. On one hand, few of the above substantial fruits lessen the PEIA effectiveness. On the other hand, too much time and cost for them also influence the overall effectiveness.

As for contextual effectiveness, legal and institutional contexts have been discussed in Chapter 4. The selected three cases were conducted under the similar contexts. Therefore, contextual effectiveness needn't further be evaluated in this chapter. Regarding normative and incremental ones, they need further time-consuming investigation. In addition, it is hard to identify incremental effectiveness of individual watershed-PEIA, because the improvements in decision-making mindsets, environmental awareness, the participatory cultures and the institutional arrangement are cumulative consequences of numerous social efforts.

(1) Case Set No. 1 in Fujian (the Jiulong River)

1) Overall Arrangements and the Involved Agencies

Tab. 5.13a The PEIA Arrangements for Integrated Watershed Plans in Fujian

	1999-2002	2005-2006	2006-2007
> 500km^2	**Edition and examination of plans**	**Revision of plans**	**Watershed PEIAs**
Responsible agencies (organizers)	Fujian Water Conservancy Bureau; Fujian Development and Reform Commission		Provincial Environmental Protection Bureau (Organizing the PEIAs)

Undertakers （editors）	Fujian Design Institute of Water Conservancy and Hydro-electric Power; Fujian Planning Institute of Watershed Conservancy	6 Qualified PEIA Agencies
Approving body	The Provincial Government	Provincial Environmental Bureau
Fund Sources	Provincial Water Conservancy Bureau; Provincial Development and Reform Commission (raising money, each for half)	Provincial Development and Reform Commission

PEIAs for integrated watershed plans in Fujian have undergone two rounds of efforts. They were respectively conducted for 68 large-scale watersheds and 905 small-scale ones. The cases in the two rounds were linked up.

PEIAs for the large-scale ones were initiated in 2006, when the watershed plans had been almost finished. In these cases, the 68 watersheds were merged into 21 ones for the integrated plans, based on the geographical and watershed features. Thus 21 PEIA reports were prepared for the large-scale ones. For the watershed plans undertaken by the prefecture-level cities and the cities, the watersheds were also merged based on the local conditions.

Tab. 5.13b The PEIA Arrangements for Integrated Watershed Plans in Fujian

	2006-2007	**2008 （3 months）**
< 500 km^2	**Edition of plans**	**PEIAs**
Responsible agencies	City governments	Provincial Environmental Bureau; Provincial Development and Reform

	˅	Commission; Provincial Water Conservancy Bureau
Preparation agency(editors)	Qualified water conservancy agencies	9 qualified PEIA agencies and other EIA agencies
Approving body	Provincial Water Conservancy Bureau; Provincial Development and Reform Commission	Environmental agencies in each prefecture-level cities
	Provincial Government	
Fund Sources	The governments in associated prefecture-level cities, city governments and counties, with the assistances from the provincial governments	The government in each prefecture-level city

As for the cases in the second round, three types of rivers were categorized: the rivers merging into the above 21 large-scale watersheds (Here the Jixi River and the Wubuxi River were combined to be one) (Type I), those pouring into the sea (Type II) and those flowing outside Fujian (Type III) (Tab. 5.14). For Type I, only one EIA report was edited for all entering the same large watershed. For Type II and III, one EIA report was prepared for each river. In addition, for saving the time and cost, the PEIA conclusions at the high tier were adopted for reference in the PEIA processes at the lower tier in the second round.

The schedules and the involved agencies at each stage of the planning processes and the PEIA processes are as shown in Tab. 5.13a. The case in the Jiulong River is particularly adopted for exemplifying the details about the work route of the large-scale ones in Fujian.

The PEIA was initiated after the integrated plan report in the Jiulong River had been finished. Moreover, in the latest revision of the plan, totally 125 engineering projects for reservoirs and hydropower stations were involved, only for 21 of which construction had not been initiated. Even, some projects, which had been built or were being built, were not included in the plan. The lagged watershed plan and the excessively late integration of PEIA into the plan may lead to the extremely limited effectiveness of the EIA. That holds true in most cases of Fujian. Therefore, the PEIA for the Jiulong River is a retrospective EA, focus on evaluating the current environmental status. The plan was organized by *Fujian Water Conservancy Bureau* and *Fujian Development and Reform Commission*. *Fujian Design Institute of Water Conservancy and Hydro-electric Power* is responsible for undertaking the planning process and editing the plan, as the consignee. As for the PEIA, Fujian Provincial Environmental Protection Bureau organized the PEIAs for integrated watershed plans, under the support of *Fujian Water Conservancy Bureau* and *Fujian Development and Reform Commission,* which consigned the PEIA task to one of the qualified PEIA agencies. Fujian Environmental Protection Bureau organized the examination of the PEIA by calling together the representatives from various sectors, and the experts; *Fujian Water Conservancy Bureau* and *Fujian Development and Reform Commission* are also involved. Then the revised planning report, based on the comments from the examination team and the PEIA report, was submitted for approval to the provincial government, accompanied by the PEIA report and the comments. Other cases in Fujian, such as one in the Qiuluxi River, also follow the above arrangements.

As for the cases in the second round, the work route is similar to that in the first one. The involved agencies are shown in Tab. 5.13b, and the details are not illustrated here.

It is clear that the duties of each responsible agency and the fund sources (Tab. 5.13b) were specified in the arrangements and many agencies are involved. However, the final decision-making power is under the control of the provincial government, specifically *Provincial Water Conservancy Bureau and the Provincial Development and Reform Commission*. They are organizers, funds-providers, examiners and in fact they also participated in the approving bodies of the plans and the PEIAs. Although

Provincial Environmental Bureau is responsible for examining and approving the PEIA, its comments are influenced by the provincial government to a great extent.

2) Substantial Effectiveness

Despite the institutional and technical deficiencies, anyway, some achievements have been obtained in the watershed-PEIAs of Fujian. Totally 117 hydropower projects have been deleted and 147 ones need a careful argument, because they didn't accord with the PEIA results for the large-scale watersheds in Fujian Province. As for the case of the Jiulong River, four unbuilt hydropower projects were recommended to be deleted from the plan and two need further assessment. Those achievements indicate that environmental policies have been integrated into the plans in a sense. However, their substantial effectiveness is limited due to the following deficiencies: late integration of PEIA into the planning, inadequate data, lacking appropriate CEA methods, limited public understanding and others.

Moreover, as responded in the interviews, the CEA results in the case of the Jiulong River were not convictive and not clear for the decision-makers, so they preferred the environmental consequences of individual project to cumulative ones, when implementing the PEIA results. It is clear that the unclear and qualitative CEA results influence the final adoption in the plan.

3) Procedural Effectiveness

Among those deficiencies in procedures, too late integration of SEA into the planning process is fatal and decisive, so that the EA results could only help explain the established facts. As documented above, PEIAs for the large-scale watersheds in Fujian were initiated when the watershed plans had been almost finished. The case for the Jiulong River is not an exception, which commenced after the integrated plan report had been finished; as discussed above, the lagged watershed planning and the excessively late integration of PEIA into the plan have limited the substantive effectiveness. Most cases of Fujian exhibit similar characteristics of substantive performance.

In addition, limited time doesn't allow of sufficient data collection, complete surveys and systematic analyses. The PEIAs for most of both the 68 large-scale watersheds and 905 small-scale watersheds were required to be finished in only *three* months (The case of the Jiulong River was finished in five months). Nine qualified PEIA agencies and approximately 20 EIA agencies in Fujian were involved in the small-scale cases, each of whom was assigned with one or more PEIA reports and even part of whom need to finish more than 10 EIA reports in the three months (Tab.5.14). It can well be imagined that the mass-produced EIA reports may be rough, which holds true in most cases. The PEIA reports act only as the administrative tasks of the involved agencies. Most of the PEIA actors often follow the minimalistic principal and only try to play touch ball and find a loophole of the laws and regulations.

Technically, the case of the Jiulong River mainly followed *Technical guidelines for PEIA (HJ/T130-2003)*. The main principals in this PEIA include: the main first-order tributaries and river sections in the main streams being as the PEIA units; CEA being as the focus by retrospective assessment, attaching importance to social and economic evaluation, risk assessment, alternatives and mitigation measures. No follow-up and monitoring was actually involved, which is the common phenomenon of the current watershed management. Despite the consideration of alternatives in its technical route, the aforementioned established facts make it an empty shell.

As for CEA, it has gained some concerns in the draft PEIA report for the integrated watershed plan of the Jiulong River. As shown in its draft PEIA report, 'the excessively dense development projects may alter the hydrodynamic conditions (e.g. slower flow and declining water exchange capacity), which often influence the degradation of pollutants and thus the water quality may be altered '; 'the original river ecosystem has been destroyed' and 'the unbuilt projects may add insult to injury, but will not exert subversive influences on the river ecosystem across the whole watershed', because there were only 21 unbuilt projects in the plan. However, the abundant small-scaled projects for water conservancies and hydropower stations along the branches, which were not involved in the integrated watershed plan and its PEIA domain, may bring substantive environmental consequences. In addition, few information about aquatic creatures was available, which increased the difficulty in assessing cumulative ecological consequences. Therefore, the cumulative effects of them could not be fully assessed. Moreover, the current CEA methods could not help to provide the convictive results. Further, the CEA results were seldom adopted in the final decision for easier implementation of the plan.

Tab. 5.14 Assignation of the PEIA Tasks for Integrated Watershed Plans in Fujian (For small-scale watersheds, their areas being less than 500 km^2)

Nine PEIA agencies acting as go-betweens	No. of the involved EIA agencies	No. of the involved rivers	No. of EIA Reports for three types of rivers	Total No. of EIA Reports for each go-between
A	6	449	8 (I)	31
			17 (II)	
			6 (III)	
B	1	163	1 (I)	15
			8 (II)	
			6 (III)	
C	2	119	2 (I)	21
			19 (III)	
D	2	13	3 (I)	6

			3 (II)	
E	5	44	1 (I)	7
			6 (II)	
F & G	1	16	1 (I)	1
H	2	54	2 (I)	2
I	2	47	2 (I)	21
			19 (II)	
Total	21	905		104

I: For the rivers, which respectively merge into one of the 22 large-scale watersheds in the first round of PEIAs for integrated watershed plans, one EIA report needs to be prepared for all small-scale ones into the same watershed.

II: For the rivers pouring themselves into the sea, each one needs one EIA report.

III: For those flowing outside Fujian, each one needs one EIA report.

Further, limited data availability is still an important factor of influencing the watershed-PEIA results, although environmental sectors, Development and Reform Commissions and water sectors of various levels were required to help collect data, data collection of several times and field investigation were done, and the comments from the public were also collected. For example, only 12-year data for annual precipitation and sediments were available for statistically assessing hydrological regime at the Baisha Station of the Wananxi River and no detailed information about aquatic creatures were used for assessing the influences on ecosystems in the case of the Jiulong River. In addition, meteorological data were gathered based on administrative regions, but hydrological data were watershed-based. Thus, they are hard to match with each other. Further, the hydrological data of some dam sites were not obtainable, which were the focus points of the PEIA, although 20-year data of each hydrological station had been obtained.

Touching public participation, theoretically, their comments seemed to have been considered in the whole watershed-PEIA process. In practice, e.g., the Jiulong River, the involved public includes the general public, as well as the experts. Two rounds of questionnaire were conducted, the first being designed for consultation on the experts (23 experts) and the second for the comments from the general public (472 respondents). Based on the questionnaire for the general public, 71% of them had never heard of the integrated plan and only 13 of the left people were familiar with it. 'On one hand, it indicates that the public concern little on watershed plans; on the other hand, it also shows that the government has no enough propaganda' (the draft PEIA report of the Jiulong River).

All these inadequacies in procedures, particularly the late integration of PEIA into the decision-making process, have greatly restricted the role of PEIA in the planning process. Even though credible and satisfying EA results were obtained, most of the contents of the plan had been established before initiating the PEIA.

4) Trans-active Effectiveness

In the case of the Jiulong River, half a year was taken and approximately 400000 Yuan was cost for this PEIA. If substantive effectiveness is satisfactory, the time and cost for it should be deserved. However, that does not hold true. In addition, too limited time restrained the full assessment of environmental potentials.

5) The Other Aspects of 'Overall Effectiveness'

The above analyses presented the main technical difficulties. However, the technical proficiency alone, in fact it being not the case, can't ensure the effectiveness of the planning process and its associated PEIA and it is the institutional dimension that decides the acceptance of the PEIA conclusions or not and implementation of the PEIA. Also the institutional backgrounds and arrangements influence the technical dimension, such as the involved agencies and individuals, the PEIA process and even the adopted EA methods. For instance, as for CEA, the cases in Fujian have given cursory concerns on cumulative effects, more or less, but the CEA conclusions were not adopted in the final decision because the environmental agencies preferred 'precise answers', such as the view declaring 'the projects to be deleted', to uncertain CEA results. That further indicates the role of administrative power in watershed management and environment protection. For provincial rivers, the decision-making power of watershed management is mainly under the control of the local governments.

(2) Case Set No. 2 for the Major Seven Watersheds (the Yangtze River)

1) Overall Arrangement and the Involved Agencies

The new round of revision focuses on the following rivers: the Major Seven Rivers and important trans-boundary rivers; rivers with water shortage, frequent floods and droughts, fragile ecosystems and environments; rivers with rich hydropower and disorderly developments of hydropower stations. Ministry of Water Resources, accompanied by the associated ministries of State Council and the associated provincial governments, is responsible for organizing the revision; watershed management commissions shoulder the specific responsibilities of revising the plans, with the support of the provincial water conservancy management agencies and others. According to the overall arrangement, both watershed management agencies and provincial water conservancy agencies have taken part in the revision efforts as the main bodies. Provincial water conservancy agencies shoulder the responsibility of organizing the revisions of other rivers, as well as providing watershed agencies with supports for revising the plans of the Major Seven Rivers. For meeting the requirements of nation-wide revision of integrated watershed plans, the management agencies of the Major Seven Rivers in China and the provinces in those watersheds have respectively issued their arrangements for the plans.

For example, for the Yangtze River, the Yangtze River Commission is the organizer, responsible for designing the technical route and assigning the tasks to the involved agencies. The involved provincial government agencies help collect data and provide the planning comments in their respective jurisdictions, with the support of their various agencies. As for its watershed-PEIA, Water Resources Protection Bureau of the Yangtze River took on the EA tasks, with the support of the involved provinces. Based on the revising schedules of integrated watershed plan, the time period for PEIA was from March, 2007 to December, 2008, less than 2 years. PEIA was integrated into the planning process at the early stage.

In fact, Water Resources Protection Bureau is the subordinate of its corresponding watershed management commission. That means self-assessment conducted by the planning agency itself. Thus, the PEIA report works only as the plan's passport, rather than an actual environmental protection instrument.

Moreover, Ministry of Water Resources attends the examination of watershed-PEIAs for the Major Seven Rivers in China, as well as Ministry of Environmental Protection and other associated ones. Experts from Ministry of Water Resources are planners, PEIA managers, and people for examination. The approval of integrated watershed plan, including its PEIA, is in the hand of State Council. As noted in previous chapters, environmental protection in water resources and watershed management, which have the most difficulties among various sectors, is a hard nut to crack for the environmental sectors. For example, there are two sets of water quality data in each watershed, which have great differences between them, respectively from its environmental sector and its watershed management agency.

2) Substantial Effectiveness

The adoption of the case at the Estuary of the Yangtze River as a good example in *Comments on SEA Cases* of the EPD (Environmental Protection Department), PRC (EPD, 2009, 2nd) indicates its success in some sense. In addition, clear and understandable documents are praiseworthily.

3) Procedural Effectiveness

Tab. 5.15 Main Methods at Each Stage of Watershed-PEIA of Comprehensive Harnessment and Development Plan of the Yangtze River Estuary

Main PEIA stages	Main methods
Investigation and analyses of environmental baseline	Data collection, field investigation, monitoring, images interpreting
Preliminary analyses of the planning alternatives	Matrix, expert consultation
Identifying environmental effects	Matrix, expert consultation
Predicting and analyzing environmental effects	Overlays, mechanism analyses, statistics, scenario analyses
Integrated analyses of environmental effects (analyses of environmental benefit and CEA)	Overlays, expert judgment
Publication participation	Colloquia, consultation session, expert consultation, questionnaire

As for technical arrangements, the following advisable aspects need to be noted: early integration of the PEIA into the planning process, detailed explanation of the PEIA methods and procedures, consideration of spatial dimension and temporal duration of environmental effects, and recognition of CEA. These help to improve the veracity of the EA results in some sense, which deserve to be referenced in similar cases.

Different from the cases in Fujian, when initiating Comprehensive Harnessment and Development Plan of the Yangtze River Estuary, PEIA has been integrated into the planning process. Moreover, technical arrangement was clear and understandable, which provided the main methods at each stage (Tab. 5.15). However, besides the listed methods in Tab. 5.15, methods appropriate for watershed-PEIA, especially its CEA, need to be developed, which will be discussed in Chapter 6.

Systematic analysis of cumulative effects is the highlight of this watershed-PEIA case (Comprehensive Harnessment and Development Plan of the Yangtze River Estuary). Firstly, synergistic and antagonistic effects were identified between its different specific plans. Secondly, this case focused on the following three aspects of cumulative effects: aquatic ecosystems, wetlands, and water environments. The details of cumulative potentials in each aspect were presented in the report. However, too many details about cumulative effects in the lower-levels are not advised for the higher-level PEIA, such as the PEIA of integrated watershed plan. Moreover, the temporal and spatial scales of the environmental consequences also deserve to be noted and used for reference.

The influences on aquatic ecosystems are characterized by those on types and patterns of aquatic habitats at the estuary, and those on fish species, integrity and continuity of fish spawning fields, fish feeding fields and fish wintering fields. Mechanism analysis, statistics, overlays and expert judgment are adopted for assessing them. As for the cumulative effects associated with wetlands, wetland areas, integrity of natural protection regions, and wetland resources and types in flood lands were analyzed by mechanism analysis, overlays, and statistics. Moreover, when assessing the cumulative effects on water environments, the following three aspects, water quality in various water function areas, water quality and salinity in sources of drinking water, were systematically illuminated.

Several alternatives were systematically analyzed and their environmental potentials were assessed and compared, but 'no-development' alternative was not mentioned. That identifies that the final decision is to 'have to approve one of the alternative proposals'.

In regard to public participation, as listed in Tab. 5.15, colloquia, consultation session, expert consultation, and questionnaire have been adopted in this case. The involved region is developed and education levels of the stakeholders are generally high. Therefore, online investigation in this region is feasible. However, only one way is not enough for sufficient comments from the public and only 67 effective questionnaire responses were available, which were not enough for such a large-scale plan.

4) Trans-active Effectiveness

Touching the case at the estuary of the Yangtze River, the PEIA process experienced six years from 2001 to 2007 (MEP, 2009). If that's true, six-year efforts are indeed not desired. As for the costs, no information was provided.

5) Contextual Effectiveness and Others

In this case, Water Resources Protection Bureau of the Yangtze River is responsible for the PEIA process, which is the underling of the planning agency, Water Resources Commission. Both of them are under the control of MWR, PRC, directly or indirectly. That is to say that MWR is responsible for both the planning process and the PEIA process. In addition, de jure, Environmental Protection Department strengthened the management of watershed-PEIAs, which is responsible for examination and approval of the PEIA report; de facto, National Development and Reform Commission plays a determinant role in approving the plan and the PEIA report. That means existence of self-assessment, self-examination and self-approval. Therefore, increasing political supports, which holds true in current China's government, despite it is not enough at present, are desirable.

(3) Case Set No. 3 for Watershed Hydropower Plans (the Muli River)

1) Overall Arrangement and Involved Agencies

In 2003, hydropower plan of the river section from Shangtongba to Abudi, the main stream of the Muli River, was launched. Subsequently, its PEIA was initiated before the plan report was finished in April, 2004. However, the PEIA report was examined and approved in July, 2004, later than the time of examining the plan report, May,

2004. That implies that the PEIA results could not be fully integrated into the planning process.

As for the involved agencies, they are similar to the cases in Fujian. A subordinate technical agency of MWR at a municipal level was responsible for its plan and the PEIA. Provincial Development and Reform Commission and Provincial Water Resources Department were responsible for examining the plan and Provincial Environmental Protection Bureau is responsible for examining and approving the PEIA report. The involved agencies are virtually under direct control of local government, showing that the provincial government has played an important decisive role in both the planning and PEIA processes.

2) Substantial Effectiveness

Similar to the the case of the Jiulong River, late integration of SEA into the watershed planning process is the overriding factor limiting its substantial effectiveness, which indicates that the PEIA results couldn't be fully integrated into the planning process.

In addition, the case is born out of project-EIAs. It didn't fully integrate the environmental considerations into the planning process, because it couldn't reflect the PEIA's role in deciding the cascade number, the scale of each cascade, selection of dam sites and development modes.

3) Procedural Effectiveness

Based on *Technical Guidelines of PEIAs (HJ/T 130-2003)*, the PEIA procedures were arranged. The methods at various stages are as shown in Tab. 5.16, which include Project-EIA ones and those specific to PEIAs. Most of them are general EIA methods. Among them, environmental models, Delphi method, and environmental carrying capacity were used for CEA of watershed developments, which are also commonly used in other PEIA cases, especially Delphi method.

In this case, four alternatives were involved and comparatively assessed, besides the brief analysis of '0' alternative. In fact, in most PEIAs, the finale of the PEIA is to help the plan to be approved. The development of the four alternatives had considered environmental elements.

CEA, as an integral part of PEIA, had been conducted, but no details about its results were presented in the report. More information about the environmental implications of individual project was introduced, including those in the construction and operation periods. Moreover, this PEIA only covered part of the Muli River. Water resources and hydropower projects in the upper reaches had not been developed. Therefore, the cumulative environmental implications in the upper reaches were not involved in this case.

As for public participation, three ways were adopted: social investigation of the general public, panel discussion and expert consultation, monographic study. For environmental influences on aquatic and terrestrial creatures, professional knowledge is necessary and EIA experts have no capacity to cope with them. Therefore, in this case, experts with such knowledge were consigned to undertake researches on those problems, for ensuring the accurate outputs.

Tab. 5.16 PEIA Methods for the Hydropower Plan in the Muli River

Main Stages	Methods
Preliminary Screening of planning alternatives	Checklists, matrix, Delphi method
Investigation and analyses of environmental baseline	Data collection, field investigation, monitoring
Identification of environmental effects	Networks, flow charts, Analogism
Public participation	Statistical analyses, checklists, Delphi method
Prediction and assessment of environmental implications	Environnemental model, comparative analyses, Index

	analyses, analogism
CEA	Environmental model, Delphi method, environmental carrying capacity

4) Contextual Effectiveness and Others

Similar to the case of the Jiulong River, the provincial government played an important and decisive role in both the planning and PEIA processes. As for the achievements in environment awareness and participatory cultures, they are important for influencing the implementation of PEIA in essence. It needs a long time to show them. Therefore, they are not analyzed in this study.

5.4 Summary

In this chapter, document study, questionnaire and interviews, and case study are adopted for discussing the current practices of watershed-PEIAs in China. The main contents include current watershed-PEIA practices, identification of the main challenges and research priorities based on questionnaire and interviews and evaluation of effectiveness and performance of the selected cases of the Jiulong River, the Estuary of the Yangtze River and the Muli River.

SEA for various watershed plans have been undertaken across China, which include those for hydropower plans, flood plans, irrigation plans and navigation plans, besides integrated watershed plans. However, only watershed-PEIAs for integrated plans and hydropower plans were expounded, because currently they are the major watershed-PEIA types in China.

Aforementioned nation-wide revision of integrated watershed plans in the Major Seven Watersheds and other important ones have been initiated in 2007 and have almost been finished. The new revision of integrated watershed plans involves two ways: watershed-based and province-centered. Thus, each province arranged its own schemes of watershed plans, providing information and references for those in the Major Seven Watersheds. Based on the technical procedures, EA is a necessary step of the planning process. Therefore, series of watershed-PEIAs have been correspondingly conducted in large-scale watersheds and their associated provinces.

In Fujian, most rivers are provincial and few inter-provincial conflicts need to be solved. In addition, their PEIA processes are mainly dominated by local government agencies. Data collection and organization of the PEIA process are easier than those in the Major Seven Watersheds. However, more over-centralization and more government intervene may lead to more difficulties in integrating environmental consideration into the planning process.

Besides integrated watershed plans, PEIAs for watershed hydropower plans also have comparatively more experiences than other single-purpose watershed plans. In addition, there are more journal articles and dissertations about PEIAs of hydropower plans.

As depicted in Subsection 5.1.3, no endeavors on SEA for water policies. Environmental implications in water policies, nevertheless, don't allow underestimation. For example, disorderly SPH development in southwest China is mainly attributable to Incentive Policy of SPH, which has caused severe ecological issues such as river channel shrinkage, dry rivers, water and soil loss, and the destruction of aquatic eco-systems and so on. That indicates the necessity of SEA for water policies.

Section 5.2 aims to collect the comments from experts with watershed-PEIA experiences. The focused people are EIA experts in Research Institutes of Water Resources under the control of the Major Seven Watershed Commissions, those associated with watershed-PEIAs in Fujian, water conservancy and hydropower agencies, and those authors of journal articles about watershed-PEIAs. Based on analyses of the comments obtained in questionnaire and interviews, the core ideas were summarized as follows.

Firstly, the necessity of watershed-PEIAs was acknowledged by the overwhelming majority of the respondents in the questionnaire. Secondly, preliminary identification of deficiencies were conducted in CEAs, consideration of alternatives, analyzing EIA results, time of integrating PEIA into watershed management, public participation and selection of EIA agencies. Lacking systematic CEA, insufficient consideration of alternatives, inaccurate EA results, seldom actually integrating PEIAs into watershed management, and limited public participation were realized by most of the respondents. Moreover, parts of them were analyzed in depth when undertaking case study in Sub-section 5.3. Thirdly, the main limitations leading to the above deficiencies, including technical and institutional ones, and future research priorities were also analyzed, based on the respondents' ideas. As for the main factors limiting effective watershed-PEIAs, insufficient researches about watershed-PEIAs, inadequate watershed management system, lacking clear and unambiguous guidelines for watershed-PEIAs are specific to watershed management, among those receiving more attention. To break through the above limitations, all the listed research topics received more or less concerns, with no distinct priorities in the responses of the multiple-choice questions. However, the responses to open questions and the interviews, overriding attention was paid to CEAs of watershed developments. In addition, great varieties and confusion in technical arrangements of different watershed-PEIA cases, which have been verified in the investigation outputs and the subsequent case analyses, indicate the necessity of developing a general and systematic framework for guiding future watershed-PEIAs, CEA being as an integral part. Thus, this research could provide foundations for other associated research topics, including those listed in the question paper and those presented by the respondents.

Further, in regards to effectiveness of watershed-PEIAs, the investigation reflects the general recognition of the effectiveness of watershed-PEIAs. However, few of the respondents think 'effectiveness to a great degree'.

Section 5.3 analyzed the three watershed-PEIA cases for explaining their overall arrangements, the involved agencies, and their effectiveness. Their performance is systematically evaluated and summarized as follows based on the above analyses.

Substantive effectiveness

Environmental considerations are included in the plan for selecting an environment-friendly alternative is the ultimate objective of watershed-PEIA. In the Case of the Jiulong River, the PEIA only played a very limited role in integrating environmental considerations into the planning process, because the PEIA was initiated after the plan had been finished and only an extremely small portion of the involved engineering projects had not been built. However, it is deserved to be noted that four hydropower stations were forbidden. As for the Muli River, its PEIA report was examined after the plan had been approved, which indicates that the PEIA results were not fully integrated into the plan. In the case at the estuary of the Yangtze River, the early integration of the PEIA realized the interaction of the planning process and the EA process; when proposing the plan and editing the technical route, environmental considerations were involved. Regarding the PEIA documents, it is worthy of high compliment that the technical route, the adopted methods, the procedures, the assessment and prediction results, comparison of alternatives, and the measures were orderly presented in the PEIA reports of the Yangtze case and the Muli Case.

Procedural Effectiveness

Limited data availability is common for all the three cases, due to high confidentiality of watershed data. In addition, different data standards from various sectors also influence their adoption and the PEIA results.

Early integration of environmental considerations into the decision-making process is the original intention of PEIAs, but few PEIA practices meet it. Usually, late integration of PEIA is the decisive factor contributing to the failure of actually implementing environmental policies.

Technically, no advanced guidelines have been developed for watershed-PEIAs and most of the adopted methods are general ones for project-EIAs, appropriate for assessing the environmental implications of individual project. Therefore, great differences exist in adoption of the EA methods in the three cases, mainly dependent on the professional capacity and experiences of the PEIA actors.

As for CEA, all the three cases have considered it more or less. In the case of the Jiulong River, only cursory concerns on cumulative effects were given and the CEA results were not accepted by the decision-makers. In the other two cases, CEAs were systematically undertaken and Delphi method was the main method. However, more convictive and pellucid details were necessary for coping with arguments and integrating the results into the decision-making process.

Selection of the most environment-friendly one from all alternatives, including '0' alternative, is the ultimate objective of the PEIA. Only the case for the Muli Watershed involved '0' alternative. However, economy-dominant conception often makes 'no-development' alternative an empty shell, which means that the PEIA is the passport of approving the plan in essence.

'Follow-up and monitoring' are the necessary measures for ensuring the actual implementation of the PEIA results and modifying them if appropriate due to great uncertainties in watershed developments and environmental predictions. The factors for follow-up and the time periods for monitoring were arranged in the PEIA reports of all the three cases. However, in most cases, the approval of the PEIA report and the plan report often means the end of the planning process.

In regards to public participation in the decision-making process, it is often questioned by environmentalists and NGOs for environmental protection. In brief, the current problems in public participation of watershed-PEIAs mainly include 'the general public's willingness of participation', 'the government's willingness and action of publicizing information' and 'public understanding '.

Among the above analyses of effectiveness, analyses of the cases mainly reflect the components associated with procedural and substantial effectiveness. At the same time, institutional contexts are also reflected in these cases. These achievements and deficiencies in these components could help explain the status of watershed-PEIA practices in China. In addition, their technical details, under the current watershed management institutions, also reflect the status of China's watershed-PEIAs.

Institutionally, grounding on the above analyses, for large-scale integrated watershed plans, they and their PEIAs are virtually determined by MWR and NDRC, PRC; those of small-scale watersheds are under more control of their local governments. Technically, CEA methods need to be particularly noted and CEA framework of watershed developments will be developed as an integral part of the watershed-PEIA system.

As noted in ADB (2009), the main obstacles limiting the PEIAs in China could be categorized into two aspects: non-technical factors and technical ones, which have been proved in Chapters 2, 4 and 5. Technical limitations could be overcome in steps, together with the worldwide efforts, but the institutional and political backgrounds, , which play vital roles for the effective PEIAs and have received increasing concerns, need to be improved collaboratively by the governments of various levels, other associated agencies and the whole social efforts.

Chapter 6 Watershed-SEA Framework with Indicator System

As discussed above, both non-technical and technical dimensions influence the PEIA (Plan-EIA, environmental impact assessment for plans) process, the PEIA conclusions and integration extent of the PEIA into the plan. On one hand, an enabling decision-making system is necessary, including political willingness and supports, defined and enforceable legislations, effective institutions, and vocal cultures. On the other hand, the technical dimension, such as procedures and methods, also needs to be greatly improved. Large amounts of efforts are required for developing advanced PEIA techniques, which is particularly true for large-scale watershed-PEIAs. Moreover, improvements in legal, institutional and cultural contexts, which are impossible to be achieved in a short term both for China and any nation, will have more difficulties than the technical ones. Therefore, the first imperative is to develop a general watershed-PEIA framework, together with the systematic analyses of associated CEAs (cumulative effects assessment) and indicators. As for non-technical dimension, suggestions for promoting the improvements of decision-making backgrounds for sustainable watershed developments and watershed-SEAs will be produced.

6.1 Current Watershed-SEA Framework in China

Based on the above research outcomes, the current watershed-PEIA system could be concluded and obtained. That will be the foundation of establishing an application framework for SEA (strategic environmental assessment) of watershed management.

6.1.1 Legislative and Institutional Deficiencies

The major deficiencies include unclear and inadequate legislative provisions, weak law enforcement, and complicated conflicts in water management system. They have fundamentally influenced the implementation of watershed-PEIAs: the process, the results, and particularly the acceptance of the EA conclusions in the plan or not. For example, the issuance of *The 2003 EIA (environmental impact assessment) Law* led to the prevalence of watershed-PEIAs for various watershed plans, especially after the promotion of the Fourth EIA Strom, which focused on 'Watershed-based Limitative Ratification'.

6.1.2 Deficiencies in Watershed-PEIA Processes

Deficiencies in watershed-PEIA processes mainly include the following aspects: few actual early-integration, little adoption of public comments, insufficient consideration of cumulative consequences and less advanced CEAs. All of them are under the influences of the legislative and institutional ones more or less. In addition, complicated physical processes of watersheds, especially large-scale ones, often increase the difficulties of watershed-PEIAs. Therefore, methods appropriate to watersheds' characteristics are desirable for increasing the accuracy of the results.

6.1.3 Current SEA Tiers for Watershed Management

Necessity of integrating SEA into watershed management has been fully analyzed, which also comes down to necessity of SEA for water management policies, as well as PEIA. Analyses indicate SEA should be integrated into all actions of various levels: polices, plans and programmes, as well as projects. However, SEA for water management polices is still not available, despite their great environmental implications. Currently, PEIA is the main type of SEA for watershed management in China.

6.1.4 Current Technical Framework for Watershed-PEIAs

As discussed in Chapter 4, *Regulation for EIA of Watershed Plans (SL45-2006)* provides the technical references for current watershed-PEIA practices. Besides the general procedures shown as Fig. 4.1, appropriate methods at each stage were also briefly introduced. However, more details, especially those about CEA and indicators, are necessary for a general guideline, according to the analyses in Chapter 4.

6.2 Improving Legislative, Institutional and Cultural contexts

6.2.1 Legislative Improvements

In Chapter 4, associated laws and regulations were presented. *The 2003 Law*, *Ordinance of PEIA*, and *Regulation for EIA of Watershed Plans* were particularly analyzed. For overcoming their limitations and perfecting the legal contexts, lots of efforts need to be considered.

For *The EIA Law* and *Ordinance of PEIA*, more fine points should be established specific to each sector. For example, clear provisions about 'alternatives', 'monitoring and follow-up', 'public participation' and 'post-assessment' should be provided in the law, rather than in the regulations specific to various sectors for avoiding excessively protecting their own sector interests.

Secondly, SEA for policies should be legally established. That could help timely revision of policies and regulations and even terminating them, if serious environmental potentials. Thus, SEAs for watershed management are developed as shown in Fig. 6.1. SEAs of water policies and integrated watershed plans could help provide the framework for single-purpose watershed plans, avoiding unnecessary development plans, if they are effectively implemented. Then, associated project-SEAs are undertaken in succession, under the remit of watershed-PEIAs. The EIA system will be improved from point-source to area-source EIAs and from microscopic to macroscopic levels. In addition, CEAs should also be regulated as a mandatory part of SEAs, including watershed-PEIAs and SEA for water-dependent development policies.

Thirdly, two-tiered examination system is advisable, both national and provincial EIA agencies being legally required to be responsible for EIA examination. As for watershed-PEIAs, the former one is responsible for those in the Major Seven Watersheds, trans-province ones and international ones; the latter ones mainly answer for other small-scaled ones. Moreover, the latter ones should be directly under the control of the former one as powerful environmental agencies separate from local governments for avoiding disturbances of local protectionism, as well as avoiding 'internal examination'.

Further, most importantly, the liabilities of 'inactions' should be clearly established. Particularly, their execution, which has been an issue in a long period, needs to be legally enforced, or else they are null. However, in fact, this problem is not easily to be solved. Therefore, an authority comprising experts of various disciplines and NGOs is also suggested to be established in each Environment and Resources Protection Committee (i.e. Supervision Committee in Fig. 6.2) under the system of People's Congress of China at all levels for supervising SEAs, so that the government behaviors could be effectively restrained.

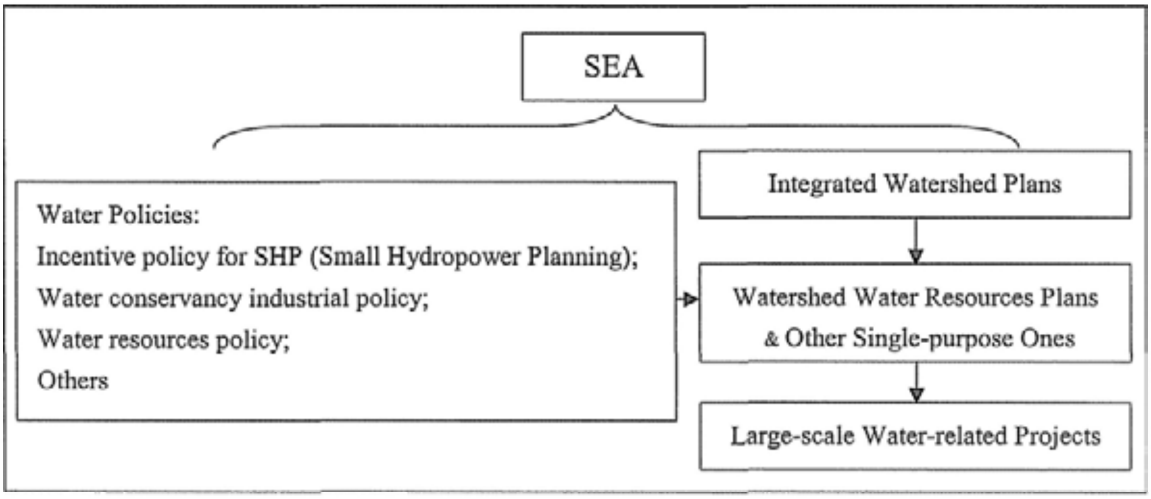

Fig. 6.1 Desired Legislative Framework of SEAs for Watershed Management

6.2.2 Institutional Contexts

In water management system, conflicts between sectors and between administrative regions and watersheds are overriding for limiting watershed-PEIAs. In addition, as for watershed-PEIAs, contradictions between water management and environmental protection further increase the difficulty in watershed-PEIAs.

For overcoming the conflicts between watersheds and administrative regions, their rights and obligations should be clearly regulated. Legally, watershed management agencies are difficult to be endowed the powers of executing the law due to various resistances. Administrative powers often play overriding roles in managing affairs of developments. Therefore, their administrative powers are expected to be strengthened in the institutional reform.

Currently, the desired institutional framework is expected to be developed according to Fig. 6.2. In this framework, incorporation of Supervision Committee particularly stands out. Its members include NGOs and the general public, as well as experts of various disciplines. Its main function is to supervise the environmental agencies about whether they have effectively implemented EIAs of various levels in different sectors. The committee members have rights to monitor the EIA process, the involved agencies, the EA conclusions, adoption of the conclusions and post-assessment and address inquires to the responsible EIA agencies and people, if any problem in them. Further, the courts will prosecute them according to the improved and enforced laws about environmental protection and EIAs and based on the evidences provided by the committee. When the committee questions the above issues, the objects being inquired are the EIA-managing agencies: MEP (Ministry of Environmental Protection), PRC and local environmental protection agencies.

MEP (Ministry of Environmental Protection), PRC and local environmental protection agencies should be authorized to examine and approve the EIA process and the EIA results. In addition, it is also responsible for managing the qualification of EIA agencies. Functionally, provincial environmental protection agencies should be under direct control of MEP (Ministry of Environmental Protection), PRC. They should be endowed with the administrative powers of restraining the actions with environmental potentials in various development sectors. As for watershed management, these environmental agencies should hold powers of administering water quality, water environments and ecosystems in watersheds, which surpass the managing capacity of water resources management agencies (Ministry of Water Resources, watershed management commissions and provincial water conservancy agencies) of its same level.

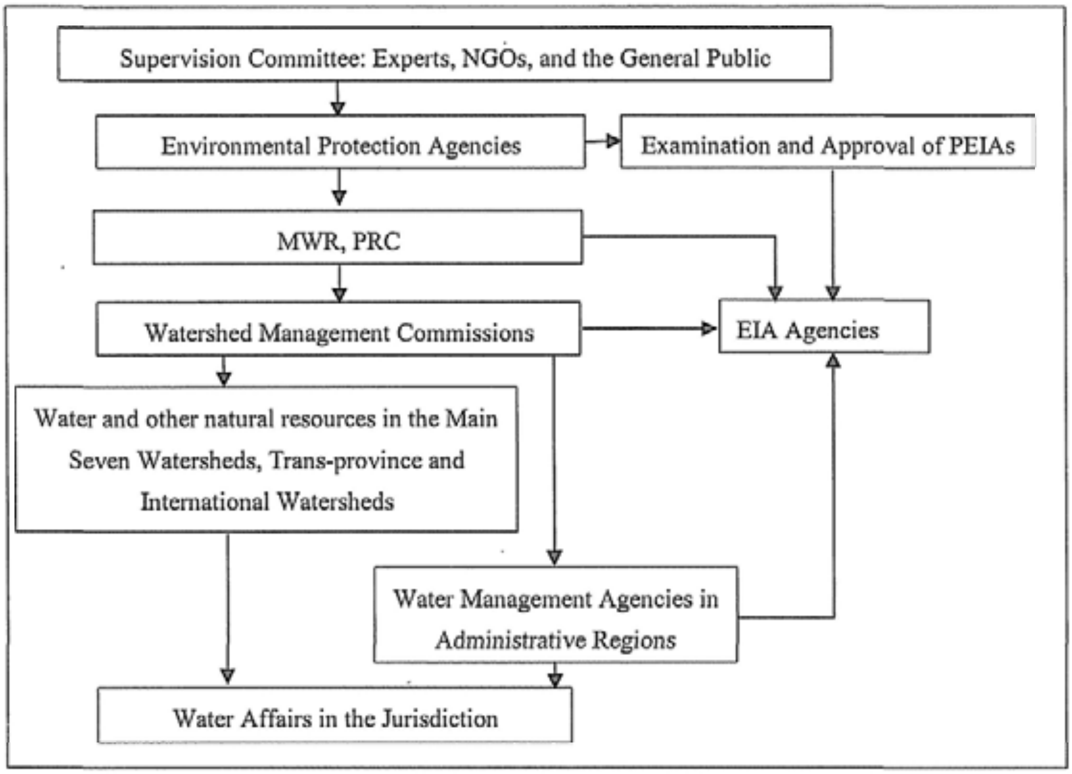

Fig. 6.2 Institutional Arrangement of water and watershed management

The above institutional and administrative arrangements are suitable for EIAs of various sectors. As for EIAs of watershed management, water resources management agencies at different levels are responsible for organizing the EIA task of their own level by entrusting it to qualified EIA agencies. MWR (Ministry of Water Resources), PRC undertakes the EIA of water and watershed policies; Watershed management commissions shoulder the responsibilities of conducting EIAs of various levels, from integrated watershed plans and associated single-purpose watershed plans to involved projects, in the Major Seven Watersheds, trans-province and international watersheds; local water management agencies assume the obligations of assessing environmental implications in watershed developments of other watersheds. More than half members of watershed management commissions should be provincial or county stakeholders or experts of various associated disciplines or offices of various associated sectors. As for water affairs, only watershed management commissions and local water management agencies have rights to manage them. At the same time, they also have to shoulder obligations of failing to effectively manage watersheds. Thus, existent conflicts in watershed management could be overcome and EIAs associated with watershed management will be more effectively implemented in some sense.

Currently, administrative powers have long played overriding roles in watershed management. Therefore, political supports are absolutely necessary. Particularly, National and Provincial Development and Reform Commissions often have power of life and death over the development ways and contents of various sectors.

6.2.3 Cultural Contexts

Administrative management remains dominant for watershed management and environmental management, although perfect legislations for them are desired. In addition, long-standing cultural backgrounds also have potential influences on EIAs of watershed management mainly by influencing public participation and administrative systems.

On one hand, in current cultures, social members often hold the attitude that 'let things drift if they do not affect one personally' and 'out of position, out of administration'. Thus, the stakeholders are unwilling to participate in what is none of their own business. On the other hand, low education levels may influence the capacity of public participation. As for watershed management, public participation is confronted with more difficulties, especially for the stakeholders in the upper reaches of watersheds. Therefore, for reducing the negative influences of current cultural backgrounds on watershed management and EIAs, associated information of watershed developments and associated environmental potentials need to be widely publicized. In addition, education universalization is desirable for improving the capacity of public understanding and perception, especially in rural areas.

Moreover, traditional cultures also influence the administrative actions, ideas, and systems. For example, enclosed administrative system makes the decision-making process lack transparency. That's also the main reason of inactive public participation.

6.3 Technical Framework with CEA as an Integral Part

6.3.1 Procedural Framework

PEIA is the main type of SEA, which is true for SEAs of watershed management. Here, technical framework of watershed-PEIAs is the focus in this section. Technically, general SEA principals, procedures, methods and contents have been presented in *Technical Guidelines for PEIA (trials)* and *Regulation for EIA of Watershed Plans (SL45-2006)* introduced technical details specific to watershed-PEIAs, which have been elaborated in Chapter 4.

Firstly, public participation was not involved when preliminarily analyzing the plan and at the follow-up and monitoring stage according to the watershed-PEIA procedures shown in Fig. 4.1. Secondly, no method specific to watershed management was particularly touched, besides large amounts of general SEA approaches. Thirdly, no details about CEAs were provided, which are the emphasis and difficulty of PEIAs. Fourthly, when editing the EIA report, only two ways were mentioned: adoption of the environment-friendly alternative or revision of the planning alternative, which means that 'no-development' alternative was not noted and it is certain to adopt the development proposal regardless of the watershed-PEIA conclusions. In fact, each of the above aspects associated with the main deficiencies could be a whole research topic. However, here, the following subsections in Chapter

6 emphasize only the procedures, indicators and CEAs for effective watershed-PEIAs.

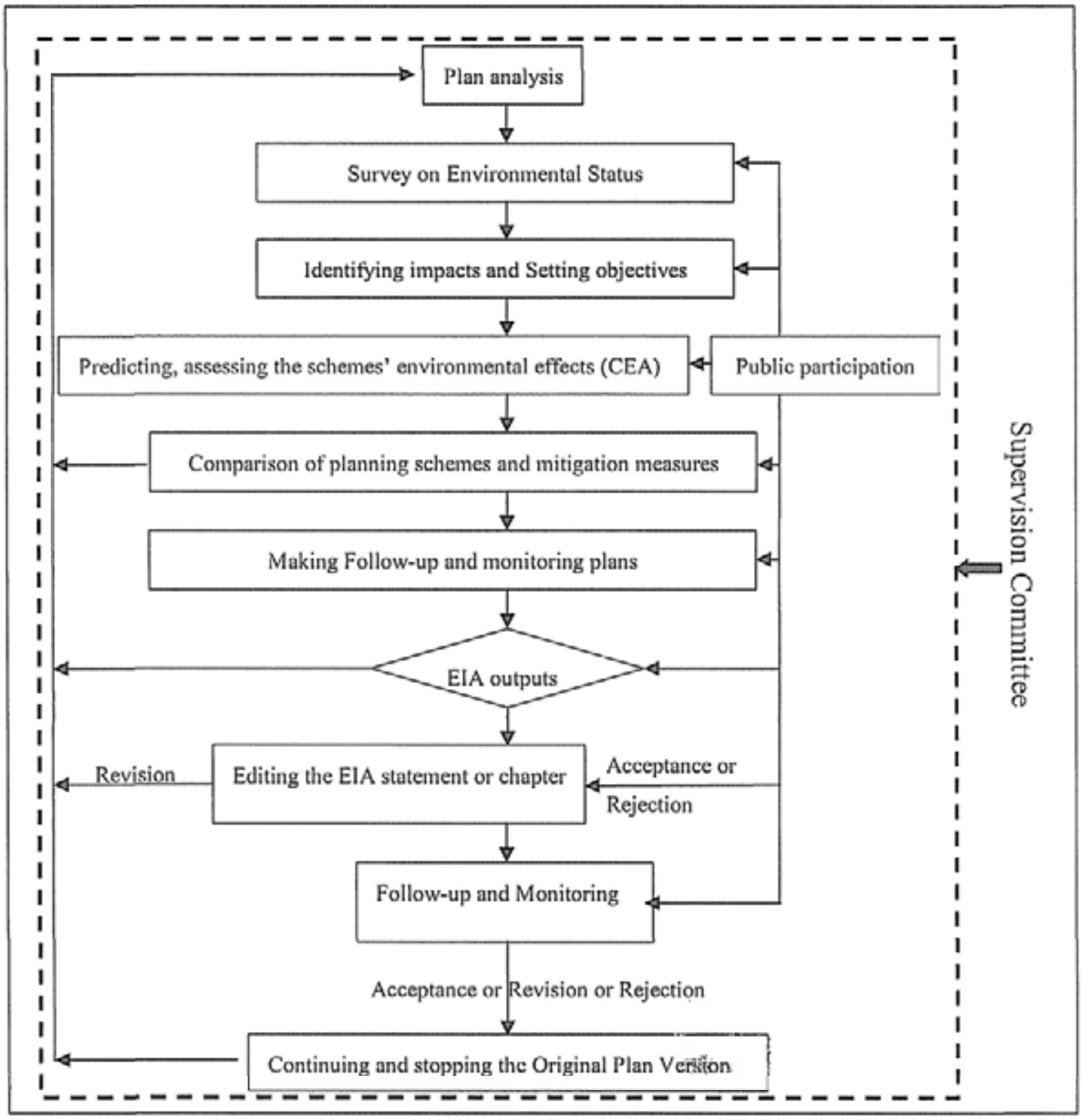

Fig. 6.3 Watershed-PEIA Procedures

Based on previous researches and above analyses, the whole PEIA process should involve public participation. Although public involvement is often confronted with many troubles in practice, at least it should be fully considered in terms of theory. Concerning CEA, especially for watershed-PEIAs with large-scale developments and complex physical functions, it ought to be integrated into the PEIA process as a focus, rather than as an understatement. As for alternatives, their comparative analyses in current practices deserve to be eulogized, but not all development proposals should be accepted and realized. The development proposal should be rejected if enormous negative environmental potentials, especially irreversible ones, are identified in the PEIA process and no appropriate measures could be adopted for avoiding or mitigating them or making them acceptable. Further, supervision committee is suggested to take part in the whole decision-making process, supervising the planning process, the PEIA process, selection of the responsible agencies, the adoption of the PEIA results and even the post-assessment process. Thus, the watershed-PEIA procedures should be developed as Fig. 6.3.

6.3.2 Indicator Analyses

Indicators are adopted for assessing the environmental conditions and evaluating the changes in environmental receptors and factors if implementing the proposed plan. They also provide a way of tracking the progress in achieving the targets in the SEA and the plan itself (NIEA, 2009). Sustainable and effective ones are desired for helping achieve the precise EA (environmental assessment) results, if possible, and providing important references for decision-makers and managers. Sustainable development is the final objective of watershed management. However, indicators associated with sustainable watershed management were also criticized for 'degenerating into a collection of long laundry lists of variables or into compendiums of historical statistical data' (Gustavson, 1999). That is also true for the indicator systems in *Regulation for EIA of Watershed Plans (SL45-2006)* and current watershed-PEIA cases. In addition, such indicators are often developed based on political boundaries rather than watershed or ecological ones. Further, comprehensive indicators respectively painting hydro-morphology, water quality and ecosystems are seldom adopted, but a long list of single-element indicators or even raw monitoring data without being processed are common.

Development of integrated indicators such as Human Development Index-HDI, Water Poverty Index-WPI and Environment Sustainability Index-ESI and Watershed

Sustainability Index is laudable and desirable. However, oversimplicity and immaturity of them may lead to insufficient consideration of complex watershed systems.

Tab.6.1 Current Watershed-PEIA Indicator System in China (SL 45-2006)

Elements	Indicators
Hydrological regime and water resources	Population and areas in flood-prevention regions; Up-to-standard rate of flood-prevention standards; Guarantee rate of drinking water; Irrigation water requirements
Aquatic environments	Up-to-standard rate of water quality in river functional areas; Up-to-standard rate of water quality in source areas; Treatment rate of total pollutants in water functional areas; Eutrophication in reservoirs and lakes; Up-to-standard rate of groundwater quality; Recovery degree of low-temperature discharge; Environmental water demand;
Soil and land resources	Land carrying capacity Degree of change in edaphic physical and chemical properties Up-to-standard rate of soil environments Area of temporal land occupation Area of permanent land occupation Land structure
Ecosystems	Biomass Landscape dominance index Up-to-standard rate of biodiversity protection Ecological water demand Recovery rate of vegetation or green space Treatment rate of water and soil loss

Social and economic aspects	Contribution value of hydropower to Green GDP Improved area of irrigation Improved mileage for navigation Per capita net income of migrants Guarantee degree of medical treatment and sanitation

This study doesn't intend to establish indicators for sustainability assessment, which is not the current priority although sustainability is desirability and dream of watershed management. Today, the economy-led development conception is overriding and dominant, which often makes environmental factors neglected. Therefore, especially, those about environmental and ecological aspects will obtain more concerns in this research, which does not mean the insignificance of other two dimensions: social and economic ones during decision-making process. In addition, the watershed-SEAs need a set of comprehensive indicators for the EA (environmental assessment) actors to assess the integral changes or distortions in the main environmental receptors, such as hydrology, water environments, ecosystems and landscapes, rather than 'a collection of long laundry lists of variables or into compendiums of historical statistical data' (Gustavson, 1999).

(1) Familiar Environmental Indicators in Water and Watershed Management

At present, a large number of environmental indicators, especially single-element ones, have been adopted for assessing and monitoring the environmental potentials and implications in watershed developments. This subsection introduces the familiar indicators in water and watershed management, providing essential references for establishing a comprehensive and operable indicator system appropriate SEAs for watershed management.

Overview on the EA cases for water-associated management indicates that different environmental topics and indicators were adopted. Although an indicator system has been presented in *SL45-2006* (Tab. 6.1), which is adopted for current guidelines, great variation exists between different cases in practical adoption of environmental topics and indicators. On one hand, the current indicator system can't fully reflect the familiar environmental implications in watershed developments, which haven been discussed in Chapter 2. On the other hand, few indicators are appropriate for CEA (cumulative effects assessment) of watershed developments. Therefore, a comprehensive indicator system for watershed-PEIA is desirable for helping evaluate macroscopical and cumulative environmental consequences.

Familiar indicators adopted in watershed-PEIAs and those developed for water management, watershed management and assessing river health are shown in Tab. 6.2 (a, b, c, d). Although the tags of the involved environmental topics are omnifarious, they mainly include the following aspects: hydro-morphology, aquatic environments, and ecosystems. In addition, landscape patterns, which could be expounded as a separate facet of environmental changes, as well as being indicative of watershed ecosystems, will also be considered for visually displaying the alteration in surface water biology and ecosystems. As for social and economic elements, they are not the focuses of current watershed-PEIAs, so there is only sketchy explanation for them in this study and they will be evaluated in detail if sustainability assessment is conducted.

The listed indicators in Tab. 6.2 cover a majority of environmental implications in water and watershed management. Part of them has been adopted in one or more watershed management cases; the left ones are only theoretical.

Among them, those comprehensive indicators will be particularly depicted, because they could reflect the macroscopical evolution of watershed environments and ecosystems. Data of the single-element indicators or indexes could be obtained from environmental protection agencies and water management sectors for using them to develop integrated indicators. For selecting those appropriate for CEA of watershed development from the long list, a draft indicator set need to be developed firstly.

Tab. 6.2a Familiar EA Indicators in Water Sector (hydro-morphological regime)

Components	Indicators/index		References/Cases
Hydrological regime	Discharge regime		Carballo, 2009 (WFD)
	Runoff	Changes in annual runoff	Xue, 2007
	Stream flows	Annual stream flows	The Jiulong River
		Stream flows in lowest-flow month	The Jiulong River
		Dry season flow	WRI (World Resources Institute), 2000
		Possibility of flow-reducing river portions	The Jiulong River
		Length of flow-reducing river portions	The Jiulong River
		Fractal dimension of stream flows	Wu, 2008
	Water level	Fractal dimension of water levels	Wu, 2008
		Water level drawdown	Xue, 2007
	Sediment	Fractal dimension of sediments	Wu, 2008
		Annual and monthly sediment transport rate	The Jiulong River
		Watershed sediment transport modulus	Wu, 2006
		Changes in annual sediments	Xue, 2007
River continuity	Inner and outer barriers		Carballo, 2009 (WFD)
	Continuity of the river system		Xue, 2007

	Length of natural river sections	The Jiulong River
Morphological conditions	Width and depth variations	Carballo, 2009 (WFD)
	River bed substrate	Carballo, 2009 (WFD)
	River topography and morphology	Liu, 2002
	Status of riparian zone	Carballo, 2009 (WFD)
Others	Density of water networks	Zhao, 2007
	Utilization rate of rivers	Wu, 2008
	River regime and stabilization of navigation channel	The Yangtze River
	Average flow velocity	Xue, 2007
	Area of water surfaces	Xie, 2007

Tab. 6.2b Familiar EA Indicators in Water Sector (water quality)

Components	Indicators		References/Cases
Water quality	Physic-chemical parameters	Temperature	Carballo, 2009 (WFD)
		Dissolved Oxygen	
		pH	
		Suspended matter	
		Total Phosphorus	
		Nitrites	
		Total ammonium	
		Total residual chlorine	
		Soluble copper	
	Up-to-standard rate of river water quality		The Jiulong River /The Muli River /Wu, 2006/Chang, 2006 /Xue, 2007/Zhao, 2007

	Guarantee rate of water quality and quantity in source areas		The Muli River
	Up-to-standard ratio of water functional areas		The Yangtze River /The Nu River
	Up-to-standard rate of water quality in offshore marine areas		Zhao, 2007
	Up-to-standard rate of surface water in cities		Zhao, 2007
	Up-to-standard rate of waste water discharge during construction		The Nu River
	Up-to-standard rate of Industrial wastewater discharge		Zhao, 2007
	Urban sewerage treatment rate (secondary treatment)		Zhao, 2007
	Compatibility with the region's objectives for water quality		Hedo, 1999
	Eutrophication in reservoirs		The Nu River
	Eutrophication	Total Nitrogen	Oliveira, 2005 / OECD, 1994
		Total Phosphorus	Oliveira, 2005/ CEH, 2002 /OECD, 1994
		Dissolved Oxygen	Oliveira, 2005 /OECD, 1994
		Inputs of phosphate to agricultural land	EU, 1999
	Contamination by bacteria	Total Coliform Bacteria	Oliveira, 2005
		Fecal Coliform Bacteria	Oliveira, 2005 /CSD, 1996
		Fecal Streptococcus Bacteria	Oliveira, 2005

	Oxygen balance	BOD	Oliveira, 2005
		Dissolved Oxygen	Oliveira, 2005 /CEH, 2002
	Heavy Metals and organic metal emissions	Heavy metals concentration (Pb, Cr, Hg, Cd, Zn, As)	Oliveira, 2005
		Organic metals concentration	Oliveira, 2005
	Toxic contamination	Concentrations of heavy metals	OECD, 1994 /EU,1999
		Concentrations of organic compounds	OECD, 1994
	Organic matter	BOD	Oliveira, 2005/ CSD, 1996
		COD	Oliveira, 2005
	Esthetic quality	Colour	Oliveira, 2005
	Suspended solids		CEH, 2002
	Emission of persistent organic pollutants (POPs)		EU, 1999
	Consumption of toxic chemicals		EU, 1999
	Electrical conductivity		CEH, 2002
	Emission of nutrients by households		EU, 1999
	Emission of nutrients by industry		EU, 1999
	Pesticides used per hectare of utilized agriculture area		EU, 1999
	Nitrogen quality used per hectare of utilized agriculture area		EU, 1999
	Emission of organic matter from households		EU, 1999
	Emissions of organic matter from industry		EU, 1999
	Non-treated urban waste water		EU, 1999
	Qualification rate of drinking-water quality (compliance with Drinking Water Standards)		The Yangtze River /Zhao, 2007 (Neagh Bann River Basin

		Management Plan)
	Compliance with Bathing Water Standards	Neagh Bann River Basin Management Plan
	Compliance with the Quality of Shellfish Waters Regulations.	Neagh Bann River Basin Management Plan
	Water quality in designated salmonid waters	Neagh Bann River Basin Management Plan
	Salinity of drinking-water sources	The Yangtze River
	Purification efficiencies	Wu, 2006
	Damages of water quality deterioration	Xu, 2008
	Damages of reservoir sedimentation	Xu, 2008
	Water pollution	Liu, 2002
	Environmental quality index	Zhao, 2007
	COD discharge	Zhao, 2007
	NH4 and N discharge	Zhao, 2007
Water temperature	Temperature variation of discharged water	Xue, 2007
	Sphere of influences on water temperature	Xue, 2007

Tab. 6.2c Familiar EA Indicators in Water Sector (ecosystems)

Components	Indicators	References
habitats	Types of habitats	The Baishui River
	Degenerating rate of habitats	Wu, 2006
	Areas of suitable habitats	The Baishui River /the Yangtze River
	Continuity of aquatic habitats	The Yangtze River
	Loss of Habitats	Xue, 2007
	Habitats of fishes	Niu, 2006

	Status of protected habitats and species		Neagh Bann River Basin Management Plan
	Surrounding disturbance		The Yangtze River
Wetlands	Integrality of wetlands		The Yangtze River
	Layouts and stability of wetlands		The Yangtze River
	Areas of wetland natural reserves		The Yangtze River
	Area of wetlands		The Yangtze River
	Proportion of important wetlands in the total regional area		The Yangtze River
	Types of wetlands		Liu, 2006/The Yangtze River
	Degenerating rate of wetlands		Wu, 2006
Flora, fauna and biodiversity	Benthic/Macro-invertebrate populations	Trent Biotic Index (TBI)	Carballo et al., 2009 (WFD)
		Biological Monitoring Working Party (BMWP)	Carballo et al., 2009 (WFD)
		Benthic macroinvertebrate flow sensitivity index	Armanini et al., 2010
	Fish	Fish species	Niu, 2006
		Piscine Index Of Biotic Integrity	Chang, 2006
		Changes in fish species	Xue, 2007
		Cumulative influences on fishes	Niu, 2006
		Integrality index of fishes	Xue, 2007
		Survival of rare fish species	Xue, 2007
		Damages of 'spawning grounds', 'wintering grounds' and 'feeding grounds'	Xue, 2007

		Migratory fishes	The Nu River
		Endemic fishes	The Nu River
		Community composition	Carballo et al., 2009 (WFD)
		Abundance (Key species)	Carballo et al., 2009 (WFD) Nardini et al., 2008 (WFD)
		Population Structure	Nardini et al., 2008 (WFD)
		Integrality and continuity of fishery 'spawning grounds', 'feeding grounds' and 'wintering grounds'	The Yangtze River
		Migratory channels of fishes	The Yangtze River
	Rare and endemic species		Niu, 2006/Liu, 2002 /The Nu River
	Losses of rare plants		Xue, 2007
	Terrestrial vertebrates		Liu, 2002
	Survival of rare aquatic animals		Chang, 2006
	Protected areas as % of national territory and by type of ecosystem		OECD, 1994
	Integrality of ecosystems of rare species		The Baishui River / The Yangtze River
	Riparian vegetation index, RVI		Pang, 2006
	Natural productivity		Niu, 2010
	Biomass production		Niu, 2010
	Biomass		Wu, 2006/Niu, 2010 /Xue, 2007
	Ratio of Biomass in inundation area to biomass in reservoir areas		Liu, 2002
	Organism abundance Index		Niu, 2006/Zhao, 2007
	Vegetation coverage index		Niu, 2006/Zhao, 2007

	Terrestrial vegetation types	Niu, 2006
	Terrestrial animal species	Niu, 2006
	Types and distribution of terrestrial rare species	Niu, 2006/ The Nu River
	Terrestrial flora	Niu, 2006
	Terrestrial fauna	Niu, 2006
	Aquatic flora and fauna	Niu, 2006
	phytoplankton	Niu, 2006
	Zooplankton	Niu, 2006
	Zoobenthos	Niu, 2006
	aquatic macrophytes	Niu, 2006
	Losses of biodiversity	Xu, 2008
	Biodiversity index	Chang, 2006/Wu, 2008
	Forest coverage	Liu, 2002/Chang, 2006
	vascular plants	Liu, 2002
	Per capita arable lands	Chang, 2006
	Geographical spread of alien species	Neagh Bann River Basin Management Plan
	Number of Margaritifera Plans put in place	Neagh Bann River Basin Management Plan
	Status of Priority Species	Neagh Bann River Basin Management Plan
	Regional distribution of species (birds, mammals and fish) according to habitat selection criteria	Hedo, 1999
	% of threatened mammals	CEH (Centre for Ecology and Hydrology), 2002
	% of threatened birds	CEH (Centre for Ecology and Hydrology), 2002
Water and	Water and soil loss rate	The Jiulong River/Wu, 2006 /Chang, 2006/Wu, 2008

soil loss	Damages of water and soil loss	Xu, 2008
	Area of water and soil loss	Xue, 2007
	Water and soil losses	Xue, 2007
	Types of soil erosion	Niu, 2006
	soil erosion modulus	Wu, 2006/Niu, 2010
	Soil erosion rate	Liu, 2002
	Percentage of dammed slags or ashes	The Nu River
	Rate of treating water and soil loss	The Nu River
Natural protected areas	Influences on structures and functions of natural protected areas	The Yangtze River / The Nu River
	Influences on protection targets	The Yangtze River
	Types of protected areas	Niu, 2006
	Protection targets	Niu, 2006
	Areas of affected protected areas	Niu, 2006/Xue, 2007
	Nature conservation areas (already designated or eligible for designation under current regulations)	Hedo, 1999
Others	Stability of ecosystems	The Baishui River
	Ecological water demand	The Jiulong River
	Value of ecological services/ Decrease in values of ecological services	The Jiulong River/Xu, 2008
	Land Degradation Indicator	Niu, 2006

Tab. 6.2d Familiar EA Indicators in Water Sector (landscape)

Structure	Landscape fractal dimension	Xie, 2005
	Landscape fragmentation index	Wu, 2008/Liu, 2006 /Xue, 2007/ Luo, 2009
	Patch density	Xie, 2005/Liu, 2006
	Landscape congregation	Xue, 2007

	Landscape evenness	Xue, 2007
	Landscape connectivity	Luo, 2009
Patterns	Landscape diversity	Wu, 2006/Niu, 2010/Liu, 2006/Xue, 2007/ Luo, 2009
	Dominance index of landscape patches	Niu, 2010/Liu, 2006
Vulnerability and Resilience	Landscape resilience	Wu, 2006/Wu, 2008
	Landscape stability index	Niu, 2010

(2) Draft Indicator Set for watershed-PEIAs

Each of the above indicators could help explain the alteration in watershed environments more or less. However, not all of them are applicable for watershed-PEIAs in China. Especially, some of them are over-complex details for communicating the information of changes in the environmental receptors, which are not necessary for the decision-makers. Therefore, such indicators will be eliminated from the above tables (Tab. 6.2 a, b, c, d).

Comparatively, the linkage of SEA Directive and WFD takes the initiative of watershed-PEIAs across EU, which also drives the evolution of watershed-PEIAs across the world. All the watershed-PEIA cases in the EU member states analyzed the environmental implications based on the environmental topics listed in the SEA Directive: 'Biodiversity, flora and fauna', 'population', 'human health', 'soil', 'water', 'landscape', 'air', 'climatic factors', 'material assets', 'cultural architectural and archaeological heritage'. However, they are general for PEIA in various sectors and are not specific to water and watershed management. Moreover, for evaluating ecological status of rivers under WFD, three aspects of indicators are developed: hydromorphological (discharge regime, inner and outer barriers, width and depth variation, river bed substrate), physico-chemical (physico-chemical parameters) and biological ones (Trent Biological Index, Biological Monitoring Working Party, composition and abundance of fish fauna) (Nardini, 2008; Carballo et al., 2009), which are workshop-based ones. Moreover, CIRF (Italian River Restoration Centre) (2008) revised the ecological indicators under WFD (Water Framework Directive) and increased some new ones. These indicators developed by WFD and CIRF have been proved to be appropriate for assessing fluvial ecosystems. Further, indicators characterizing landscape structures and functions have proved useful in the macroscopical evaluation of watershed environments and ecosystem. SL45-2006 has noted 'landscape' in its indicator system. Therefore, the draft indicator system for watershed-PEIAs consists of the following sets: those listed in SL45-2006, those for evaluating ecological status under WFD, and those proposed by CIRF (Italian River Restoration Centre) and those about landscape characteristics (Tab. 6.3). They are mainly corresponding to the aforementioned environmental implications in watershed developments, especially those cumulative ones.

1) Indicators of Hydro-morphological Conditions

As for this dimension, three components were involved: hydrological regime, river continuity and morphological conditions, all of them contributing to the alteration of biological and ecological conditions in the watershed (EWFD, 2000). Among them, more concerns are on hydrological regime than the other two facets.

Totally, Five indicators are discussed, which have been widely adopted for assessing fluvial ecosystems under the WFD framework. They are '*flow regime*', '*inner and outer barriers*', '*Width and depth variations*', '*river bed substrate*' and '*Status of riparian zone*'.

'Streamflow', which is critical for determining integrity of river ecosystems and keeping biodiversity healthy, (Armanini et al., 2010) 'is a component of aquatic ecosystem health, and long-term alteration of streamflow characteristics can produce large changes in aquatic ecosystem structure and function' (USGS, 2003). Alteration of natural flow regime, which seems to be simple, but in fact represents a very complicated physical process, including many interlinked hydrological variables

(Parsons, 2002; Armanini et al., 2010), is the direct environmental response to watershed developments. Flow alteration 'is well recognized by ecologists as being the primary driver of' changing 'riparian ecosystem function and structure' (Gao, 2009).

Comparison of pre-and post-development flow regimes could help measure the impacts of watershed developments. Although Victorian Index of Stream Condition (ISC) could help comprehensively measure the environmental condition of rivers, integrating hydrology, water quality, vegetation, river bed and bank condition, instream habitats and aquatic life, it is widely criticized as most hydrological variables being too detailed for it. IHA (Indicators of Hydrologic Alteration) software is advisable, which was initially designed for examining the changes in flow regime caused by dam construction.

So far, more than 170 indicators, including IHA, have been developed for defining various components of flow regimes (Gao, 2009). For addressing the problem of inter-correlation of the widely-used IHA, which depict 'the impact of river regulations on flow regimes', a small set of indicators were selected in some cases (Gao et al., 2009).

'Inner and outer barriers' could be adopted for assessing the potential influences of watershed developments on both hydrological changes and river continuity. They are likely contributive to decrease or extinction of some sensitive aquatic creatures, such as mitigratory fish and lotic ecosystems.

River morphology keeps a theme with great challenges to researchers and managers. 'River width and depth' and 'River bed substrate' have been adopted for evaluating river morphological conditions. As for the relationship between 'river width and depth', both 'width-to-depth ratio' of river sections and 'channel sinuosity' help to explain it (Carballo, 2009).

Tab. 6.3 V Draft Watershed-PEIA Indicators

Elements	Indicators	Policy relevance	Integrity	Relevance to the plan	Show trends	understandable	Well-founded	Providing early warning	adaptability	Identifying conflicts
Hydro-morphology	Discharge/flow regime	Y	Y	Y	ST; LT L; R	E; D	Y; A	Y	Y	Y
	Inner and outer barriers	Y	Y	N	L; R	E; D	Y; NA	Y	Y	Y
	Width and depth variations	Y	N	N	ST; LT L; R; TN	E; D	Y; NA	Y	Y	N
	River bed substrate	Y	N	N	ST; LT L; R; TN	E; D	Y; NA	Y	N	N
	Status of riparian zone	Y	Y	N	ST; LT L; R; TA	E; D	Y; A	Y	Y	N

Aquatic environments	Physico-chemical parameters	Y	N	Y	ST; LT L; R; TA	E; D	Y; NA	Y	Y	N
	Eutrophication in reservoirs and lakes	Y	N	Y	LT; L; TA	E; D	Y; NA	Y	Y	Y
	Up-to-standard rate of water quality in river functional areas	Y	N	Y	ST; LT L; R; TA	E; D	Y; NA	N	Y	N
	Up-to-standard rate of water quality in source areas	Y	N	Y	ST; LT L; R; TA	E; D	Y; NA	N	Y	N
	Treatment rate of pollutants and total pollutants in water functional areas	Y	N	Y	L; R' TA	E; D	Y; NA	N	N	N
	Up-to-standard rate of groundwater quality	Y	N	N	L; R; TN	E, D	Y; NA	N	N	N

	Recovery degree of low-temperature discharge	Y	N	N	ST; LT L TN	E	Y; NA	N	N	N
	Environmental water requirement	Y	Y	Y	ST; LT; L; R; TA	E; D	Y; A	Y	Y	Y
Ecosystems	Trent Biotic Index (TBI)	Y	Y	N	ST; LT L; R	E; D	Y; NA	Y	Y	N
	Biological Monitoring Working Party (BMWP)	Y	Y	N	L; R	E	Y; NA	Y	N	N
	Community composition of fish	Y	Y	N	ST; LT L; R	E	Y; NA	Y	Y	Y
	Biomass	Y	N	N	L; R	E; D	Y	Y	Y	N
	Up-to-standard rate of biodiversity protection (domestic and international protection objectives)	Y	N	Y	L; R	E; D	Y; NA	N	Y	N

	Ecological water demand	Y	Y	Y	ST; LT; L; R; TA	E; D	Y; A	Y	Y	Y
	Recovery rate of vegetation or green space	N	N	N	L; R	E; D	Y; NA	N	N	N
	Treatment rate of water and soil loss	Y	N	N	L; R	E; D	Y; A	N	N	N
Landscape	Landscape dominance index	Y	Y	N	L; R	E; D	Y; A	Y	Y	N

A riparian zone occurs at the interface between aquatic and terrestrial environments, which may be defined based on different factors such as vegetation type, hydrology, topography and functions. The importance of riparian zones to water quality and aquatic ecosystems has been widely recognized (Pursey, 2003; Hunt, 2004). Moreover, it also influences the 'thermal buffering', 'the provision of shade', 'in-stream production', 'nutrient interception, storage and release', 'enhancement of bank stability', 'the provision of coarse woody material as habitats and substrate for fish, invertebrates, microalgae', 'mediation of changes in river morphology and habitat diversity' and 'refuge from disturbance at a variety of scales' including at the watershed scale (Pusey, 2003).

Variation in riparian zones is indicative of spatial and temporal changes in fish assemblages and avian birds. However, it is difficulty to identify the relationships between them and riparian buffer strips due to the multi-factorial and highly complex nature. Width and length of riparian zones, degree of fragmentation, dominant vegetation, and number of layers are factors influencing the potential of riparian zones as suitable aquatic habitats. As for degree of fragmentation and dominant vegetation, landscape analysis is feasible, analyzing the structure, shape, functions and the connection between the riparian zones and rivers.

2) Water Quality

'*Physico-chemical parameters*' involve a large family of ones, such as pH, EC (Electric Conductivity), TDS (Total Dissolved Solids), TS (Total Suspended Solid), BOD (Biochemical Oxygen Demand), DO (Dissolved Oxygen) and others. All of them are important elements of water quality. As Prasad et al. (2008) noted, standard procedures for determining them are easily available. However, details of raw data are not attractive to decision-managers, who are more concerned about the trends that can't be easily observed from raw data. Moreover, 'in spite of the fact that physical and chemical parameters characterizing water quality', certain shortcomings about the reliability of them exist due to their interaction and spatial or seasonal function of concentration ranges (Karydis, 2009). Similar shortcomings exist in the indicators 'up-to-standard rate of water quality', 'up-to-standard rate of ground water quality' and recovery degree of low-temperature discharge, which are based on the physical and chemical parameters. Therefore, use of ecological indicators, such as diversity indices, which will be discussed in the subsection 'ecosystems', was proposed for measuring water quality.

In the Jiulong River, only DO (Dissoved Oxygen), BOD_5 (Five-day Biochemical Oxygen Demand), COD_{Mn} (Chemical Oxygen Demand; Oxygen Consumed), NH_3-N (Ammonia Nitrogen) and TP (Total Phosphorus) were respectively analyzed. However, they are only applied in evaluating the current status of water quality. Prediction of them and associated parameters need the support of water quality models, based on large amounts of historical data. Long time series are not available for most water-quality monitoring cross-sections.

Entrophic waters are characterized by high nutrient concentration and excessive algae biomass. In addition, changes in community structures, decrease in water transparency, and accumulation of organic matter have been observed in entrophic waters. Numerous methods, such as 'statistical techniques, simulation models and water quality indicators', have been developed for quantitatively assessing trophic levels. Chlorophyll and nutrient concentrations, phytoplankton biomass and water transparency, and primary productivity have been considered for assessing enrichment levels. However, it is not easy to quantify entropic conditions due to the difficulties in discriminating between natural and anthropogenic nutrients, huge number of involved variables, the complex algorithms of processing data and others (Karydis, 2009).

Further, at the initial stage of eutrophication, its effects are negligible. However, even when the eutrophication phenomenon becomes obvious, which could provide early warning for the ecosystem quality (Karydis, 2009), it is still not immediately detectable due to the forenamed reasons. In addition, it is not easy to collect a large number of necessary and consistent data over space and time for eutrophication assessment.

At present, common indicators for euthrophication include variable indicators, flux indicators and continuity indicators. Recognizing the promising position of ecological indicators for evaluating water quality, 'the suitability of certain ecological indices for assessing eutrophic trends is rather established by now' (Karydis, 2009). The following ones were analyzed: Margalef's Index (species richness), Menhinick's Index (DMn) (species richness), Kothe's species deficit index (Dk), Odum's species index (Do), Hulbert's encounter index (PIE), McNaughton's dominance index (I), Simpson's Index (Ds), Simpson's Index (Ds), Evenness Index (E1), and Redundancy Index (R); among them, Menhinick's Index (DMn) (species richness), Kothe's species deficit index (Dk), Odum's species index (Do), Hulbert's encounter index (PIE), and Evenness Index (EI) were found efficient and appropriate for assessing euthrophication (Karydis, 2009). Although eutrophication was mentioned and recognized as an important indicator, but no proper analyses were provided in current watershed-PEIA cases in China, which may be attributable to the PEIA workers lacking expertise in evaluating eutrophication, besides the above obstacles.

Generally, '*eco-environmental water requirement*' is mainly classified into four categories: that for sustaining fundamental functions of river channels, that for lakes and wetlands, that for estuaries, and that for special time periods. In addition, recharge for groundwater overdraft is also noted. Correspondingly, various methods for calculating 'eco-environmental water requirement', mainly including hydrological analyses, hydraulic methods, and habitat analysis, have been developed. For water demand of river ecosystems, some hydrological approaches, such as runoff vs. time-interval curve, Tennant approach, and the multi-year average of the lowest average monthly flow, were established; hydraulics has also been adopted in this domain, such as wet perimeter method and R2CROSS method; in addition, IFIM

(Instream flow Incremental Methodology) has been widely applied for assessing the impacts of watershed developments on downstream aquatic habitats (Jiang et al., 2003). For sustaining fundamental functions of river channels, water demand used for water surface evaporation, leakage, sedimentation transport, and water entering the sea should also be considered.

As Murray-Darling Basin Authority presented (2010), environmental water requirements could be rapidly evaluated and applicable in the watershed plan. The steps mainly include assessment and identification of the key environmental assets and key ecosystem functions, developing environmental objectives and targets, determination of water requirements for key environmental assets and ecosystem functions, inputting the 'water requirements' into the modeling platform for watershed development scenarios and access the environmental implications in the scenarios.

Introduction of ecological and environmental water demand in the current watershed-PEIAs in China helps to set the minimum discharge flow of each cascade in proposed development scenarios for ensuring adequate environmental water for downstream environments and ecosystems. The maximum wastewater discharge should also be established based on environmental water demand of each development scenario. For aquatic environments, environmental water requirement is limited to that for sustaining fundamental functions, especially that for purifying pollutants in the Jiulong River based on SL45-2006. With regarding to water requirement for maintaining the ecosystem structure, functions and the water-dependent species, it was designed as an indicator of assessing ecosystems. However, in general, no distinction exists between environmental and ecological water requirement.

For example, in the Jiulong Case, no increase in pollution sources, 10% increase in pollution sources, and 20% increase in pollution sources were considered for analyzing the minimum environmental water requirement in each of the scenario. It is the water requirement for ensuring water quantity of each cross-section up to the standard in P=50% low-flow months. Regarding the ecological water requirement, minimum water quantity, the average flow in the lowest-flow month of P = 90%, was adopted only for maintaining river ecosystems against degradation, without considering water demand for pollution absorption, dilution, and self-purification.

3) Ecosystems

Responses of ecosystems to alteration and distortion in hydrological regime and water quality have been considered from various associated facets. They in turn could also be used for representing the changes in hydrological regime and water quality.

Benthic invertebrate fauna and *fish fauna* have been widely adopted as bio-indicators to describe water quality and river ecosystems, due to their high sensitivity to alteration of hydro-morphology and water quality. (Carballo et al., 2009). *Trent Biotic Index (TBI)* and *Biological Monitoring Working Party (BMWP)* could help to evaluate benthic macro-invertebrate's responses to organic pollution. BMWP is used for identifying the tolerance degree of the involved families to pollutants. That is not practical for current watershed-PEIAs in China, due to comparatively low education levels and 'being worldly-wise' of most stakeholders of watershed developments.

As for fish fauna, especially migratory and sensitive fish, disruption of river continuity often lead to the breakage of fish migratory passages and integrity of fish habitats. Community composition, abundance of key species and age, as well as the above indicator 'inner and outer barriers' about river continuity, are indicative of changes in fish fauna.

However, application of them, indicators of benthic invertebrate fauna and fish fauna will encounter some inconvenience. One of the main limitations is that few bio-monitoring data exist for most watersheds in China.

4) Landscape indictors

Landscape analysis help for understanding ecosystem structure and function at the landscape level, coupled with GIS and RS. Landscape ecology focused on three features, which are structures, functions and changes. Moreover, increasing concerns on linkage of water quality and landscape reveals that alteration in water quality and hydrological ecosystems could also be explained by changing landscape patterns (Amiri, 2009). A set of indicators, such as patch density, landscape diversity, landscape fragmentation, landscape acreage index, landscape apartness index, landscape dominance index, landscape evenness index and landscape shape index, have been developed for analyzing the changes in ecological landscape (Shlisky, 1993).

Considering the complexity of the watershed system itself and the general large-scale nature of most watersheds, especially the Major Seven Rivers, landscape analyses for assessing watershed ecosystems are receiving more and more concerns. On one hand, large-scale RS images about land cover in different time periods or pre- and post-development periods are applicable in almost all the watersheds. On the other hand, temporal and spatial patterns and alterations of them could be comparatively easily identified and monitored, especially with the support of GIS, RS and models. Therefore, landscape analysis about water quality and ecosystems are preferable to ecological indicators, which are theoretically sound but are practically limited by lacking appropriate data.

(3) Development Procedures of Indicators

The draft indicator set consists of those widely-adopted or widely-accepted indicators across the world and in China. Considering the practicality and the easy availability of their data, those in SL45-2006 are also accepted as part of the draft indicators, although most of them don't meet the criteria 'integrity'. However, not all of them are appropriate for the watershed-PEIA under study. It is advisable to select pertinent and rational indicators from the long list or to design new ones by following scientific and widely-adopted principals and criteria.

As discussed in some literature (Cloquell-Ballester, 2006), the direct process of developing indicators would include: 'to check whether the indicators that have been accepted' by the current professional researches and sectors; 'to evaluate the possibility of them being used in a specific problem'; 'to adjust or define ex novo the indicators' if the first two steps are not appropriate. Here, 'validation process' would be added to the 'direct process', as noted by Cloquell-Ballester et al. (2006). Thus, the design process of the watershed-PEIA indicators is as depicted in Fig. 6.4.

The highlight of the indicator-development framework suggested by Cloquell-Ballester et al. (2006) is '3S Methodology'. That intends to verify the suitability of the selected and new-built indicators at three validation stages: self-validation, scientific validation and social validation.

As for 'self-validation' of watershed-PEIA indicators, the responsible PEIA team itself would assure the suitability of the selected indicators and the correct design of new ones, with correct documentation. At scientific-validation stages, experts from various disciplines, especially environmental, ecological and hydrological ones, would be required to examine and verify the adapted and new-built indicators. The involvement of public participation (social validation) is also desirable although it has only limited roles. On one hand, the native public could assist to provide indigenous information for new indicators. On the other hand, consensus on the PEIA process and transparency of watershed management could be maintained in some sense for reducing and avoiding conflicts between the general public and the decision-making agencies.

Development of indicators specific to a watershed management proposal, with 'validation processes', should be an integral and necessary part of the PEIA process. It is time-consuming under the support of the PEIA team, scientists with various processional techniques, and the general public, although the application of some decision-making tools, such as web-based Delphi Tool (Web Delphi Platform), will help decrease the time and cost for validation. Therefore, here, no case study will be carried out, its feasibility having been verified.

As Cloquell-Ballester et al. (2006) noted. 'The core of the validation can be viewed as a multi-criteria multi-expert decision problem'. In this study, workshop-based criteria will be adopted for validating the applicability of the draft indicators in the case of the Jiulong River.

(4) Criteria of developing indicators

For watershed managers and decision-makers of watershed developments, it is essential to learn, with the help of the indicators, that whether water quantity and water quality could meet the various requirements, whether water quantity and water quality will lead to unsatisfactory distortions in ecosystems, and whether the social and economical developments will be limited if the development proposal under study or one of its alternatives is accepted. In addition, for some environmental issues, if none of them is appropriate, development of new indicators is necessary (See Fig. 6.4.).

As for criteria of developing and selecting environmental management and watershed management indicators, lots of researches have been conducted (Oliberia, 2005; Chaves, 2007; Zandbergen, 1998; Dale, 2001; Donnelly et al., 2007). Criteria developed by Donnelly et al. (2007), which were developed by a workshop-based approach, will be the main references, together with consideration in other researches. They are specified in Tab. 6.4.

As Donnelly et al. (2007) noted, practicability is advisable, which means the cost-effectiveness and easiness of constructing the indicator, when they discussing the criteria 'Be well founded in technical and scientific terms'. Regarding 'adaptability', it means that the indicator system should be adaptable to the planning process, due to changes in the identified environmental implications. Besides the criteria in Tab. 6.4, 'high sensitivity to stressors' and 'reliability' should also be considered (Dale, 2001).

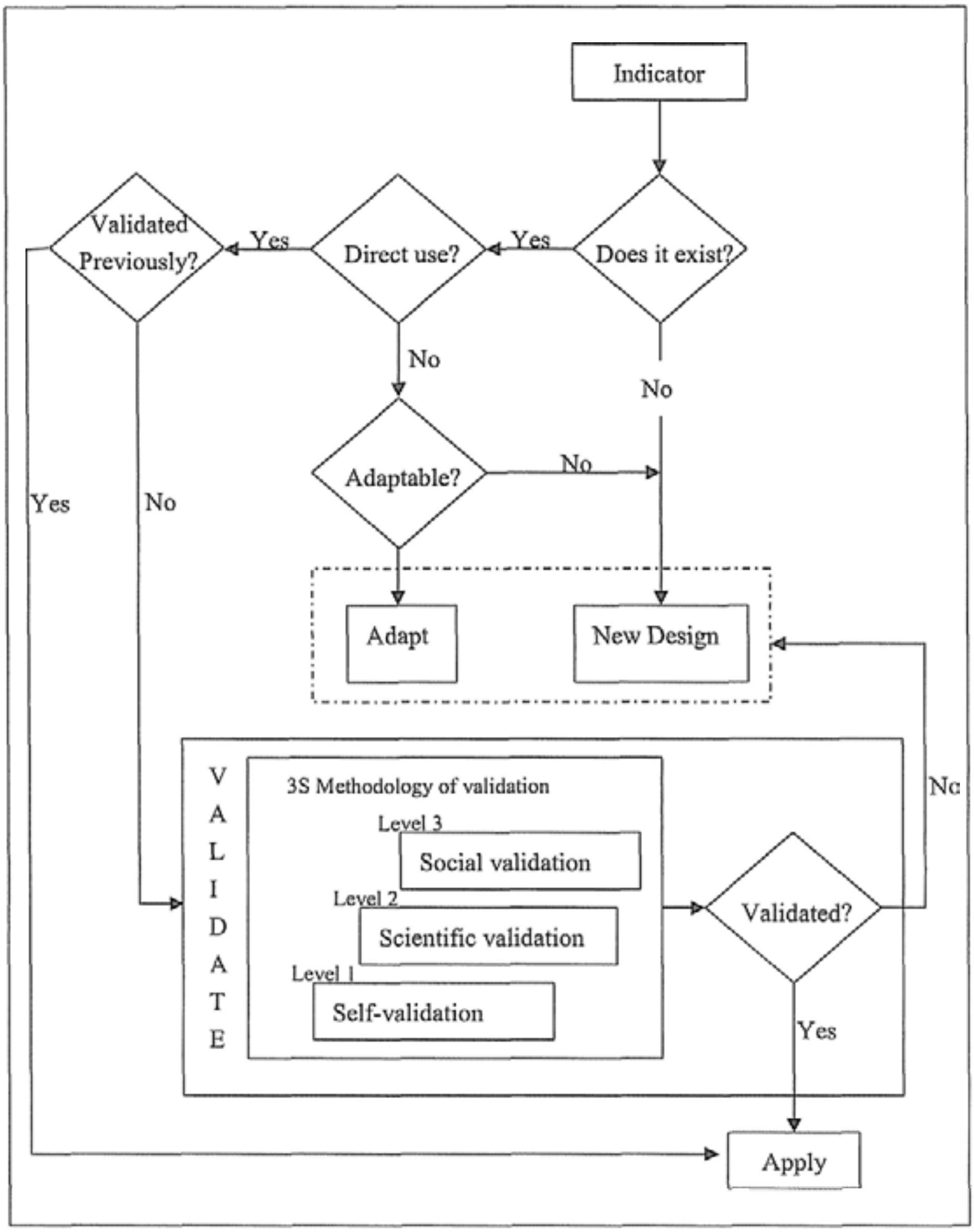

Fig. 6.4 Development Process of the Indicator System for a watershed-PEIA

(Oliberia, 2005)

Tab. 6.4 Criteria of Selecting Watershed-PEIA Indicators

(Modified from Donnelly et al., 2007)

Criteria	Brief Introduction	Performance code
Relevance to policies	Consistent with significant legislation in existence (those discussed in Chapter 4)	Y = yes N = no
Integrity	Covering a range of environmental receptors and being reflective of a wider system. The data gathered should provide information that extends beyond that which is being measured.	Y = yes N = no
Relevance to the plan in question	Environmental impacts specific to the plan should be detectable.	Y = yes N = no
Ability of showing trends	Responsive to change, measurable, capable of being updated regularly, demonstrating progress towards a target	ST = short term effect LT = long term effect
		? = positive change ? = negative changes ? = positive change ? = negative changes
		W = weekly 2W = every 2 weeks 6M = 6 monthly M = monthly A = annually 2A = every 2 years; 3A, 4A etc.
		L = local R = regional N = national
		TN = does not have associated target(s) TA = has target(s) associated with it

		X = data not available
Understandable	Ability to communicate information to a level appropriate for making policy decisions and to the general public	Q = easy to be interpreted NQ = not easy to be interpreted
		E = easily understandable NE = not easily understandable
		D = easy to display ND = not easy to display
Well-founded	Data should be supported by sound collection methodologies, clearly defined, easily reproduced, and cost effectiveness.	Y = data and underlying methodology is quality assured N = data and underlying methodology is not quality assured
		A = data available at reasonable cost NA = data not available at reasonable cost
Ability of prioritizing key issues and providing early warning	Identifying areas most at risks of damage. Providing early warning of potential problems before it is too late	Y = yes N = no
Adaptability	Emphasis can change at different stages of the plan.	Y = yes N = no
Ability of identifying conflicts	With plan objectives in order that alternatives may be explored.	Y = yes N = no

(5) Case Study- The Case of the Jiulong River

For the case of the Jiulong River, applicability of some of the draft indicators has been discussed above. For the Jiulong River, available data sources mainly include hydrological and meteorological data, data about water quality from 1985 to 2005 and multi-temporal RS images, as well as the qualitative and descriptive information about hydrology, aquatic environments, ecosystems and water resources.

For some hydrological stations, they ceased operation in 1997 and, thus, the sample size is only 12. In addition, it is difficult to match the hydrological and meteorological ones due to their different monitoring areas.

Regarding water quality, some cross sections have less than 5-year monitoring data of Physio-chemical parameters. In addition, few or no information is available about non-point pollution.

As for RS images, in the 1980s, 1990s and 2000s, they are beneficial for defining the temporal and spatial changes in land-use and water and soil loss. Landscape analyses based on them could also help identify the pre-and-post-development changes in aquatic habitats and wetlands, for supplying the shortage of ecological data.

If only considering the data availability, indicators about morphology, physic-chemical parameters and ecological indicators are not advisable in this case. The above data availability also indicates the priority of landscape analyses to others, based on GIS and RS, together with the integrity and visualization of landscape indicators. Moreover, IHA software, if applicable, is desirable for assessing the alteration in hydrological regime.

As for ecological indicators, such as indicators of benthic macroinvertebrate and fish fauna, which are both integrated and sensitive, they have been widely accepted. These could reflect the distortions both in hydrology and water quality. But in this case, few or no data indicates no use of them use here.

Finally, of particular note, the validation process is subjective, only for explaining how to apply the validation criteria. In practical cases, a systematic validation including three levels, self-validation, scientific validation and social validation, is necessary.

6.3.3 CEA of Watershed Developments

Cumulative effects assessment of watershed developments has evolved since the 1970s, despite the slow evolution and the remaining problems (Reid, 2001). Many efforts have been made for theories and practices of CEA in watershed management. For example, the GIS-based cumulative hydrological impact assessments model (CHIA) was designed as an extension of ArcView, with a combination of capabilities (Strager, 2002).

Cumulative effects in watersheds are characterized by complex inter-linkages between upstream and downstream, between two sides of one river, and between surface water and subsurface water, triggered and influenced by water flow through the proposed watershed (Reid, 1998; Reid, 2001). Therefore, the triggering activities are not always those at the impact site, because the impacts can be transported through the water media (Reid, 2001). The difference of cumulative watershed effects from others is its more easily-defined physical and geographical boundaries than artificial spatial boundaries, as well as its more distinct off-site effects. The watershed boundaries are defined by topographic divides, which are easier to be set. The cause-and-effect relationships and the accumulating process of impacts are more physically to be analyzed than in administrative regions. However, the interlinking characters of environmental changes in a watershed increase the complexities for CEA. In addition, the watershed scale and physical features also influence the process of spatial accumulation and temporal accumulation, as well as the adopted CEA methods with relevant indices. The methods for watershed-based CEA process also vary in terms of the proposal's nature and objectives. Generally, the larger the watershed scale and the more heterogeneous the watershed base structures are, the more difficult the relationships and the processes are to be identified. Accordingly, more administrative regions are involved in CEA process for large-scale watershed management and more uncertainties define the corresponding CEA outputs.

Human activities at all levels can influence the hydrological characteristics, land-cover and land use types, terrestrial and aquatic habitats and biodiversity in the proposed watershed, by incremental or interactive effects, which result in collective and cumulative environmental impacts on the concerned environmental receptors. The above mentioned 'analytic methods' and potential 'planning methods', especially comprehensive ones by linking or coupling, can be selected, revised and improved for addressing watershed-based cumulative effects. However, no standard methodology for all CEAs in watersheds could be developed, and usually different kinds of watershed proposals require different specific approaches and involve different indices. Successful evaluation of cumulative watershed effects should depend on the following principles: enough large areas and enough long time scales; interdisciplinary enough for analyzing interactions among diverse impact mechanisms; geographic-focus-and-sound management techniques (Reid, 2001). Regardless of the unavoidable uncertainty, the current methods, at a minimum, can give a descriptive picture or semi-quantitative framework for decision-making.

As Reid (1998) noted, the basic notion behind cumulative watershed effects is simple to be understood, but it is difficult to assess all the potential combined environmental changes in the watershed of interest. The problems confronting cumulative watershed effects can be categorized into political and socio-cultural issues, as well as technical deficiencies (Reid, 1998). For example, one of the limitations is the unsound water resources institutions in many countries. The main limitations constraining CEA and SEA of watershed management have been explained in Chapter 4 and 5, based on the document study, investigation and case study. Currently, the serious water issues suggest that past efforts for preventing adverse cumulative watershed effects have not been successful and no workable approach exist for avoiding and mitigating them.

The CEA methods to be particularly discussed include modeling, landscape analysis, and GIS techniques, which especially meet the extremely complex and large-scale environmental consequences of watershed developments. As for 'expert judgment, it will not be detailed here, due to its extensive use in SEAs of various sectors and various levels.

(1) Modeling

Various simulation models have been developed as a simplified representation of changing environmental systems. Some of them can be selected and improved for evaluating and predicting the impacts of involved projects and other proposals in regional management on the concerned receptors. As for the underway research about SEA for watershed management, hydrological models, ecological models and eco-hydrological models, such as famous Tank model, SWAT model, TOPMODEL and WMS (watershed modeling system), are suitable tools for assessing cumulative environmental changes in water quantity, water quality, terrestrial and aquatic ecosystems in watersheds, associated with different development scenarios and selecting environmental-friendly development alternatives.

Simulation models should almost meet all the evaluation criteria of CEA methods, including temporal accumulation, spatial accumulation, perturbation types, processes of accumulation, functional change and structural change, which were developed by Smit et al. (1995). Nevertheless, limited availability of accurate data and information is a great barrier for meeting the above criteria. In addition, the environmental complexity of large-scaled regions and the actors' professional skills influence the identification of physical processes and human impacts on natural processes in the proposed regions. For this, the current CEA models are mainly conceptual or statistical, and hemi-physical ones rather than completely precise physical ones, which limit the capacity of sufficiently identifying the cause-and-effect mechanisms and accumulative process of environmental impacts. Although a completely precise physical CEA model is only *a pie in the sky*, the insistent efforts and progresses towards this are desirable. The increasing concerns on physically distributed models, especially on GIS-based distributed models, have reflected the efforts towards more physical ones, because distributed ones tend to have more precise physical structures and parameters than lumped ones. The development of computing capability, and general application of GIS and RS in CEA processes have promoted or will further promote the physically distributed CEA models, intending to more easily analyze the concerned temporally and spatially accumulative processes.

(2) Landscape Analysis

Strictly, landscape analysis is not a specific method, but a notion, here emphasizing on the landscape level and seeing landscape as the concerned receptor. In this study, landscape analysis involves a set of analytic tools for assessing the cumulative effects resulting from the proposals or actions at the landscape scale, which is often used for examining the landscape-level cumulative changes of ecological components and processes within the proposed spatial unit such as watersheds or wetlands or administrative regions(Smit, 1995; Kepner & Jones, 2007). The spatial pattern of landscapes is illustrated by the patch-corridor-matrix landscape model, which provides a beneficial tool for identifying and analyzing the landscape-level effects over time and space. For identifying the interactions between landscape patterns and ecological processes, examining the change in landscape patterns and functions, addressing the landscape-level impacts, it is desirable to combine the advanced technologies of GIS, RS and simulation models with landscape ecology theory, even involving decision-making and management instruments such as expert consultation and public participation (Leibowitz, 2000).

This method satisfies five of the above Smit et al.'s (1995) six evaluation criteria, except partially meeting the criteria of functional change. Therefore, landscape analysis has been accepted as a more practical CEA approach (Smit, 1995; Quinn, 2002; Shifley, 2008), appropriate for large-scale SEA-linked CEA process. At landscape level, Leibowitz et al. (2000) introduced three kinds of ecosystem impacts: conversion, degradation, and network impacts; and the sum of them and effects over time and space are involved as cumulative effects.

Here, the application of landscape analysis in cumulative watersheds is the main concern. The watershed landscape involves a set of interlinking environmental effects between upstream and downstream, between two sides of one river, and between surface water and subsurface water, which may often cross political and administrative boundaries. As Shlisky (1993) noted, a landscape analysis approach was applied for prioritizing watersheds for restoration, which adopted the patch-corridor-matrix model for describing the landscape structure and 'flow phenomena' for explaining the five main functions of flows: resource capture, resource production, resource cycling, resource storage and resource output. In addition, integration of landscape analysis into hydrological models, bolstered by advanced computer capacities and GIS technologies, has been increasingly adopted as one of the promising approaches for sustainable watershed management. Miller et al. (2002) and Hernandez et al. (2003) provided such good examples.

However, the widespread application of landscape analysis, as a promising method of CEA, is limited by the low availability of detailed data about initial landscape conditions at landscape level. In most cases, although the excessive landscape-level data and information are essential for trans-jurisdictional regional management and CEA models, especially when administrative borders divide a landscape, their collection is baffled by the administrative, institutional and economic barriers, together with the technical deficiency. Moreover, limited political support and limited coordination among sectors are also barriers impeding effective landscape analysis.

As previously discussed, comparing with biomonitoring data, information about landscape is more easily obtained. Despite the forcefulness of 'Benthic invertebrate fauna and fish fauna' for measuring water quality and ecosystems, 'no suitable data' means nothing. Therefore, anyway, notwithstanding those limitations, landscape analysis is preferable to the forenamed ecological indicators under WFD (Watershed Framework Development).

(3) GIS (Geographic Information System) Techniques

GIS has the potentials to store large amounts of data, save time-consuming workload, carry out spatial analysis, examine temporal changes and achieve rudimentary visual display. Therefore, the advent and improvement of GIS provide big opportunities for CEA, especially SEA-linked CEA practices across large-scale regions, such as the watershed of the Yangtze River.

Virtually, GIS is not a distinct method, but a set of techniques facilitating the applications of other methods. The functions of GIS in CEA focus on data management, spatial analysis, monitoring actions and impacts over time and space, and visually displaying outputs, as well as analyzing the characteristics of temporal accumulation and spatial accumulation of environmental impacts. GIS-support for simulation models can be classified into four levels: assessment of environmental baseline and regional characteristics; estimation of the parameters; modeling in GIS; coupling of GIS and models. For achieving the above functions, the linkage of GIS and various models, such as hydrological models and ecological models, has been increasingly concerned. Huang et al. (2002) presented three coupling methods of GIS and environmental models, which can be used for reference and revised for achieving the coupling of GIS and CEA models; the three approaches to their coupling are loose coupling of GIS and models, tight coupling and full coupling of GIS and models. Thus, the linkage of GIS and various CEA models is principally based on the following approaches: embedding models in GIS, embedding GIS into models, as well as the above three ones (Fig. 6.5). These approaches could be adopted for developing GIS-based CEA models when conducting watershed-PEIAs. The development of GIS-based CEA models need the collaborative and workshop-based efforts of experts specializing in GIS technologies, watershed management, environmental management and ecological management.

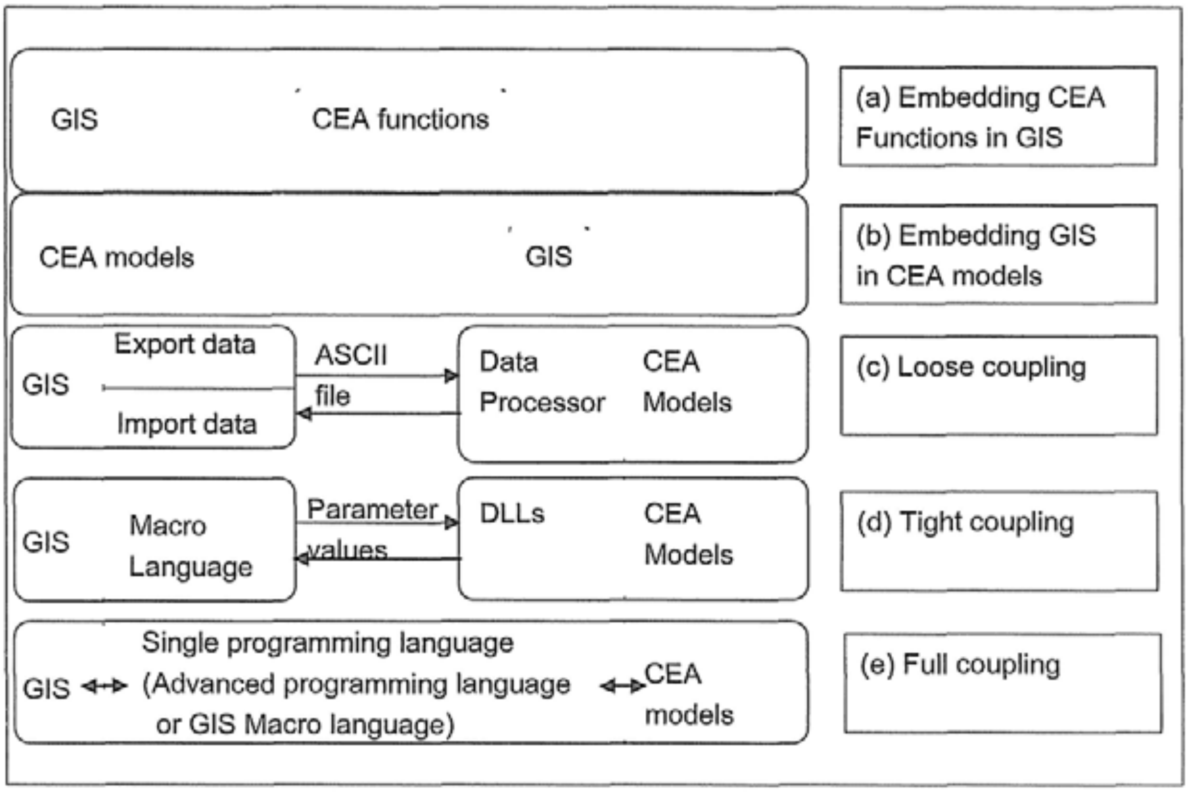

Fig. 6.5 Different approaches to the linking of CEA models with GIS

(Modified from Huang et al., 2002)

Internationally, many cases have successfully applied GIS technologies in CEA process. For example, Strager et al. (2002) mentioned the CHIA GIS Model, as an ESRI ArcView extension, used for assessing cumulative hydrological impacts by delineating the affected spatial area, illustrating environmental baseline condition, identifying hydrological concerns and assessing effects. However, the application of GIS in CEA, especially the coupling of GIS and CEA models, is still confronted with many challenges. Firstly, the difficulties and cost-consuming features in obtaining GIS data, particularly those of high-resolution and long-history, indeed are baffling the CEA actors. Secondly, the threshold of each relevant receptor can't be specifically incorporated into the underway CEA process. The last but not the least is its failure to considering the cumulative processes and the causal relationship (Smit, 1995). Accordingly, it is desirable to integrate the sub-modules or models reflecting cumulative process and causal relationships into the GIS system. Nevertheless, the coupling of GIS and CEA models require both professional information-processing techniques and environmental management knowledge, which is a great challenge for GIS professionals and CEA participants. Fortunately, the progress in the linkage of GIS and hydrological models provide expensive experience for the coupling of GIS and CEA models, especially in the researches and practices of cumulative watershed impacts. The above mentioned prevalent cases of coupling GIS with hydrological models can be selected and improved for CEA in watershed management.

The above methods belong to 'Analytical approaches' or 'Impact Approaches'. Matrix, network analysis, checklist and others of this kind have been discussed in a rich set of literature, which needn't unnecessary details here. In addition, the more common 'Planning approaches', especially for watershed planning process, are also useful (CEQ, 1997; Smit, 1995).

In this sub-section, three practical methods of CEA were particularly mentioned: landscape analyses, hydrological and ecological models, and GIS techniques, in view of the generally large scale of a watershed and the complexity of the associated environmental potentials. Moreover, of particular note, CEA should be considered as an integral part of the watershed-PEIA process. It is not dispensable. Therefore, CEA is the key part of the improved watershed-PEIA framework.

6.4 Summary

This chapter is the core of the whole study, developing the framework and establishing the indicator system specific to watershed-PEIAs. The main contents include the main deficiencies in current watershed-PEIA framework, the current SEA tiers for watershed management, the current technical framework for watershed-PEIAs, suggestions for improving the legislative, institutional and cultural contexts, and the new-developed technical framework for SEAs for watershed management with CEA as an integral part.

Both institutional and technical deficiencies exist in current watershed-PEIA framework in China. Non-technical deficiencies tend to fundamentally impact the effectiveness of watershed-PEIAs. Technically, few actual early-integration, little adoption of public comments, insufficient consideration of cumulative effects and less advanced CEA methods are common limitations in general PEIAs. For watershed developments, it is necessary to develop specific methods and indicators, especially those for CEA.

Currently, PEIA is the popular type of SEA for watershed management. Recognizing the necessity of SEA for water-related policies, the desired watershed-SEA framework is legally suggested as shown in Fig. 6.1, including four aspects: water policies, integrated watershed plans, specific plans and large-scale water-dependent projects.

Institutionally, incorporation of Supervision Committee, including NGOs, experts of various disciplines and the general public as the members, is particularly prominent. Environmental protection agencies are directly supervised by it. For all environmental issues in water and watershed management, environmental agencies have rights to inquire water and watershed agencies of various levels. Therefore, environmental agencies need to be endowed with the power for environmental protection in various sectors. Moreover, the affiliation of water-related agencies needs to be regulated for avoiding over-centralization of local governments.

However, of particular note, institutional improvement does not imply to completely overthrow the current one. Or else, a mess is possible if the old one disappeared, but the new one had not been established or had not been accepted by the public.

Technically, the new developed procedures involve CEA, consideration of 'no-develop' alternative and Supervision Committee. As for indicators, the draft system was developed, mainly referring to the indicators in SL45-2006 (*Regulation for EIA of Watershed plans*), WFD (Watershed Framework Directive) and CIRF (Italian River Restoration Centre). They were classified into four aspects: hydro-morphological conditions, water quality, ecosystems and landscape, which are dependent on the main environmental implications in watershed developments as discussed in Chapter 2. As for the indicator-development procedures, the framework suggested by Cloquell-Ballester et al. (2006), highlighting '3S Methodology' of self-validation, scientific validation and social validation, was recommended for reference. During the systematic validation stages of indicators, the workshop-based criteria developed by Donnelly et al. (2007) were proposed for adoption in future SEAs, including SEAs for watershed management. In this study, the case of the Jiulong River, Fujian, exemplified the application of those criteria to validating indicators.

Moreover, CEA, as an integral part of SEAs for watershed management, was expounded. The characteristics of cumulative environmental implications in watershed developments were identified and analyzed. Correspondingly, CEA methods appropriate for watershed developments, such as models, landscape and GIS technologies, were also particularly analyzed, which need further researches.

Chapter 7 Conclusion and Research Directions

7.1 Summary of the Study

This study intends to answer the three questions: 1) Is it necessary to integrate SEA into watershed management? 2) Are/have the technical contexts or the political backgrounds or both baffling/baffled the effectiveness of watershed-SEAs in China? 3) How can SEA be effectively integrated into watershed management? To answer them, the key SEA themes, theories of watershed management, and theories and practices about watershed-SEAs have been defined in Chapter 2, analyzing and discussing the main environmental implications in watershed development and necessity of watershed management and especially the necessity of watershed-SEAs, as well as providing fundamental information for achieving the core objective of the study. In Chapter 4 and 5, the status of watershed-SEAs was identified, mainly expounding associated laws and regulations, watershed management institutions, as well as identifying the main challenges and research priorities of watershed-PEIAs based on comments from the interviews and questionnaire. Chapter 6 proposes a context-specific watershed-PEIA framework. The highlights include incorporating Supervision Committee into the watershed-PEIA process and integrating CEA as the core part from the technical perspective. Moreover, this chapter also contributes to development of SEA indicators for assessing environmental implications in watershed developments and CEA methods appropriate for current watershed management.

Clearly, the whole study encircles the SEA effectiveness for watershed management. In Chapter 2, all the involved SEA themes in discussing SEA evolution, including CEA, public participation, uncertainties and contexts, are important components of assessing SEA effectiveness. In addition, Overall Effectiveness Criteria were developed based on previous efforts about SEA performance criteria. In Chapter 4, the legal and institutional obstacles limiting effective watershed-PEIAs were analyzed and identified, as well as the evolution and improvement in non-technical dimension. In Chapter 5, the questions for questionnaire and interviews were designed mainly considering the evaluation components of SEA effectiveness, for identifying current main challenges of effectively applying SEA into watershed management. Moreover, three cases were selected for evaluating their performance based on the applicable components of the 'Overall Effectiveness Criteria' developed in Chapter 2. As for 'How can PEIA be effectively integrated into watershed management?', Chapter 6 developed a SEA framework specific to China's watershed management contexts and technical levels in order to make the utmost possible efforts to improve watershed-PEIA effectiveness at present.

7.1.1 Necessity of SEA for Watershed Management

As indicated in Chapter 2, limitations in project-EIAs, benefits of SEAs and unfriendly environmental implications in watershed developments, especially large-scale, long-term and cumulative ones, combine to explain the necessity of SEA for watershed plans and water polices. Current severe condition in watershed environments and ecosystems presses for environmental consideration in watershed management of various levels.

Sustainable development is the overriding objective of both watershed management and SEA. However, current watershed-based management of water resources and other natural resources can't focus on mainstreaming environmental protections for achieving its multi-objective purposes, especially environmental objectives.

7.1.2 Watershed-PEIA Effectiveness and Challenges in China

(1) Effectiveness

As responds in questionnaire and interviews, there is the general recognition of watershed-PEIA effectiveness in a sense. 'Effectiveness to a great extent' is not true for most respondents.

Moreover, effectiveness of the selected cases in Chapter 5 was evaluated based on available components of 'Overall Effectiveness Criteria'. The Effective Criteria mainly include six aspects: substantial effectiveness, procedural effectiveness, trans-active effectiveness, incremental effectiveness, normative effectiveness and contextual effectiveness, as expounded in Chapter 2. Between them, overlaps exist in some extent.

For the cases of the Jiulong River and the Muli River, environmental considerations could not be fully integrated into the planning process because the watershed plans had almost been finished when conducting PEIA. To be worse, the great majority of the involved water-dependent projects had been initiated or even finished when developing the plan, not to mention its subsequent PEIA. Comparatively, the case for the estuary of the Yangtze River harvested more substantial effectiveness, due to its timely integration, clear and orderly documents and procedures, and systematic analyses about CEA. The case of the Muli River also assessed cumulative effects and produced an understandable report in a detailed manner, but its late PEIA was the overriding factor of leading to its substantial failure.

As for their procedural effectiveness, it is restricted mainly by low availability of data, late integration of PEIA into the watershed plan, no advanced guidelines and methods, insufficient CEA and lacking actual consideration of 'no-development' alternative and poor public involvement. Moreover, in most cases, the approval of the PEIA report and the plan report often identifies the end of the PEIA and the planning process, although all the three cases noted 'follow-up and monitoring' in their PEIA reports.

Challenges

Both non-technical and technical dimensions influence the effective implementation of watershed-PEIAs in China. Non-technical constraints were expounded in Chapter 4, mainly including legislative and institutional aspects, and also identified in the investigation process of Chapter 5. As for technical deficiencies, they were exhibited in Chapter 5, based on document study, questionnaire, interviews and case study.

From the legislative perspective, many deficiencies exist in *The 2003 EIA Law* and *Ordinance of PEIA*. No details about 'post-assessment', 'alternatives', 'monitoring and follow-up' and 'public participation' are provided. Those contents about 'alternatives', 'monitoring and follow-up' and 'public participation' in PEIA report often become mere formality due to lacking provisions about legal liabilities. The rough provisions in The 2003 EIA and the details in *Regulation for EIA of Watershed Plans (SL45-2006)* and other sectoral regulations indicate the legislative tradition in China: a rough law and its subsequent fine points specific to each sector, which often leads to protectionism and excessive concerns on their own sectoral interest. In addition, no regulations about EIA for policies are enacted. Further, *Ordinance of PEIA*, another milestone succeeding *The 2003 EIA Law*, fails to regulate the liability of 'inactions' and 'internal assessment', and contents about public involvement were deleted from the draft.

Institutionally, over-complexity of the current watershed management system greatly influenced watershed management and associated SEAs. Conflicts between sectors and conflicts between watershed management and administrative management often lead to the common phenomenon of 'striving for interests' and 'eluding liabilities'. Further, watershed-PEIAs, especially CEAs, need large amounts of data from various sectors, but limited information-sharing blocks the evaluation of the environmental baseline and prediction of environmental potentials in the watershed under study.

Despite recent improvements in laws and institutions, such as the new version of *Water Law, PRC*, and establishment of Shanghai Water Affaires, government actions and administrative powers still dominate in water and watershed management. Current management system is not produced overnight, which is not advisable to overturn it at once and requires continuous reform.

As for cultural contexts, they also potentially impact the PEIA process. Both supportive and participatory cultures are necessary. However, 'apathy and short sight' of the public often make their comments claptrap and meaningless. Moreover, enclosed administrative system in traditional cultures is also contributable to inactive public participation.

Technically, *Technical Guidelines for PEIA* and *Regulation for Environmental Impact Assessment of River Basin Planning (SL45-2006)* are current technical guidelines for undertaking watershed-PEIAs, including procedures and appropriate methods at each stage. However, no details of CEA are regulated and no integrated indicators suitable for CEA are established. Further, no 'zero' alternative is carefully involved, which means the essential of the PEIA is to make a development alternative approved.

7.1.3 Improvements in the Watershed-PEIA System

As discussed previously, limitations in both non-technical and technical dimensions are restricting effective watershed-PEIAs, influencing the process, the EA results and the implementation. Therefore, improvements need to be made both in non-technical and technical dimensions.

Legally, the provisions about fine points specific to each sector, SEA for polices, 'two-tiered' examination system, the liabilities of 'inactions' were highlighted in Chapter 6. Particularly, Supervision Committee is desirable to be incorporated by NGOs and the general public, as well as the experts. The committee is legally endowed with strong administrative powers for supervising the environmental agencies about whether they have effectively implemented EIAs of various levels in different sectors.

Institutionally, watershed management agencies should be endowed with more administrative powers for managing all kinds of water affairs and balancing the trade-offs between administrative regions, because, at present, administrative management still plays an overriding role in current decision-making process, including watershed management. In addition, functionally, provincial environmental protection agencies should be under direct control of MEP (Ministry of Environmental Protection), PRC, rather than under the control of their respective local governments; similarly, water management agencies in administrative regions should be directly and functionally controlled by Watershed Management Commissions, the underling agencies of MWR (Ministry of Water Resources), PRC, rather than the supportive ones of their associated local governments.

Technically, aspects about public participation, 'alternative' analyses and CEA were also particularly noted in the new-developed SEA procedures of Chapter 6. In the new system, the public's comments were suggested to be involved in the whole PEJA process, from 'survey on Environmental Status' to 'Follow-up and Monitoring'. As for analysis of alternatives, rejection of the original alternatives is also possible, as well complete acceptance or revision. Further, this new technical system emphasizes the CEA process as an integral part of the SEA system. Therefore, indicators (those respectively for hydro-morphology, water quality, ecosystems and landscape) and methods (model, landscape analysis, and GIS techniques) appropriate for CEA of watershed developments were particularly depicted.

As for watershed-PEIA indicators, an draft indicator system was developed based on the current indicator system in *Regulation for EIA of Watershed Plans (SL45-2006)* and familiar indicators for assessing environmental potentials in watershed developments, especially those for evaluating ecological status of watershed developments under WFD. For a watershed plan in practice, the selection of indicators from the draft system and even design of new indicators will follow the procedures shown in Fig. 6.4 as established by Oliberia (2005). For both selecting indicators from the draft system and designing new ones, they need to be validated by the PEIA team itself, the experts of associated disciplines and professions, and the general public. Regarding validation criteria, the workshop-based ones, developed by

Donnelly et al., 2007, are desirable, as well as developing appropriate ones if necessary.

7.2 Constraints in the Study

This study is a pilot one in this domain. As discussed in Chapter 2, few literatures are available. Therefore, lots of associated research topics, such as theories about integrated watershed management, decision-making theories, environmental carrying capacity, public participation, and CEA, need to be respectively discussed in depth. It is impossible to address all issues in watershed-PEIAs in a study. In this study, only a SEA framework specific to watershed management, together with its draft indicator system, was developed, as well as the status of SEA for watershed management being identified. This study intends to provide preliminary information for other further topics, rather than to penetrating into one associated topic.

When conducting this study, limited data availability is the overriding obstacle. Data availability is not only a great hindrance to measuring environmental consequences of watershed developments, but also a limitation of associated researches. Most of the produced EA (environmental assessment) and planning documents are not open. Even those listed in *Analyses on EIA Cases* and *Comments on SEA Cases*, only their EIA reports are provided, without further information.

Due to the fact that watershed-PEIAs are still at early stage, few EIA actors, researchers and officers could help or are reluctant to provide beneficial ideas during he investigation process. Therefore, the questionnaire and interviews only focused on an extremely small portion of the EIA actors. In addition, few literatures, international and domestic, specifically those about watershed-PEIAs are available for reference.

7.3 Research Perspectives

As mentioned above, this study is only a preliminary one. Further companion researches will be further conducted on the following topics: IWM, watershed management system, CEA of watershed developments, environmental carrying capacity, uncertainties in watershed-PEIAs and public participation of watershed management, especially in rural areas. Each of them is an arduous assignment. Particularly, CEA methods and indicators of watershed developments should be further studied, based on the outputs in Chapter 6. Moreover, to distinguish between natural and anthropogenic changes which are often neglected, should be of particular note when conducting watershed-PEIAs and SEA for water policies. Further, the craze careerism, only trying to make money by taking on EIA assignments, may still block the efforts for associated researches.

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Appendix

Addendix I List of Respondents in Questionnaire

Code	Watershed-PEIA experience (Years of EIA)	Organization
A1	No (0)	Univeristy
A2	Yes (25)	University
A3	Yes (5)	Environmental research institute
A4	No (1)	University
A5	Yes (23)	EIA agencies (water resources protection institute)
A6	Yes (17)	EIA agencies (water resources protection institute)
A7	Yes (1)	Water resources agency
A8	No (6)	Research institute
A9	Yes (27)	Hydropowr design institute
A10	Yes (12)	EIA agency
A11	No (0)	Unitiversity
A12	No (0)	Hydropower research insitutute
A13	No (4)	Research institute
A14	No (4)	Water conservancy research institute
A15	Yes (6)	Environmental research institute
A16	No (10)	Research institute (EA agency)
A17	Yes ()	Hydropower research institute
A18	No (3)	Research institute
A19	No (20)	University (Environmental research institute)
A20	Yes (10)	University (Environmental research institute)
A21	Yes (22)	University (Environmental research institute)
A22	Yes (3)	Environmental Research Institute
A23	Yes (8)	Hydropower coordination
A24	Yes (9)	University (Environmental research institute)
A25	Yes (10)	University (Environmental research institute)
A26	No (5)	EIA coperation
A27	Yes (4)	Hydropower institute

A28	Yes (21)	Water conservancy cooperation (EA agency)
A29	Yes (7)	EIA agency (water resources protection institute)
A30	No (15)	Research insitute (EA agency)
A31	Yes (10)	Environmental Research Institute
A32	Yes (3)	EPA
A33	No (13)	Environmental Research Institute
A34	No (7)	University (Environmental research institute)
A35	No (15)	EPA
A36	No (12)	University (Environmental research institute)
A37	Yes (6)	EPA
A38	Yes (5)	EIA agencies (water resources protection institute)
A39	Yes (8)	EIA agencies (water resources protection institute)
A40	Yes (2)	EIA agencies (water resources protection institute)
A41	Yes (7)	Environmental Research institute
A42	Yes (20)	Research institute
A43	Yes (18)	Environmental Research institute
A44	Yes (12)	Environmental Research institute
A45	Yes (11)	Environmental Research institute
A46	No (1.5)	Environmental protection cordination
A47	Yes (20)	Hydropower corporation
A48	Yes (5)	Environmental Research institute

Appendix II Questions for Questionnaire

1 您认为流域规划环评是否与流域规划的水资源及生态环境保护部分相冲突（流域规划的环评篇章），为什么?

☐严重冲突，只需要规划环评，流域规划报告的水资源保护部分去掉

☐严重冲突，只需用流域规划报告的水资源保护部分，不需要规划环评

☐不冲突，两者关注点不同（部分冲突，但都需要）

☐其它

2 您认为中国是否有必要开展流域规划环评，促进流域可持续发展?

☐ 非常有必要　　☐有必要　　☐ 没有必要　　☐不知道

3 在您了解的流域综合规划或流域专题规划环评过程中，有无环境影响评价报告？

☐ 有

☐ 没有，只有规划报告中的环评篇章

☐ 没有，既没有环评报告，也没有环评篇章

4 在您了解的流域规划环评过程中，除了环境评价报告或者规划报告中的环评篇章，还包含以下哪些方面的书面报告（此项为多项选择）？

☐环境影响评价的前期筹备工作报告；

☐初步环境监察报告；

☐环境评价及评论框架；

☐详细的环境评价技术报告 （包括参与人员、方法、评价路线、成本估算等）；

☐对受影响公众的调查与咨询报告；

☐跟踪及监管报告 （不断更新修正）；

☐ 没有其它书面报告

☐其它，请说明：

5 在您了解的流域规划环评过程中，有无考虑累积环境影响评价？（此项为单项选择）

☐有，非常系统地进行了识别和预测

☐有，只对部分累积影响进行了识别和预测

☐有，只是简单描述

☐无，根本未提到累积环境影响

☐其它，请说明：

6 在您了解的流域规划环评过程中是否考虑了替代方案？（此项为单项选择）

☐是，而且有零方案，除了零方案，还有其它_____个替代方案；

☐是，没有零方案，共有_____个替代方案；

☐否，没有任何替代方案

7 在您了解的流域规划环评过程中，评价结论被规划编制机关采纳的情况如何？

☐全部采纳　　☐部分采纳　　☐极少采纳　　☐完全不予考虑　　☐不清楚

8 在您了解的流域规划环评过程中，环评介入的时机主要在规划过程的哪个阶段？

□规划编制之初　□规划编制过程中　□规划初步完成　□规划上报审批之前

9 在您了解的流域规划环评过程中，公众主要参与了哪些部分的内容？（此项为多项选择）

□环境背景调查　□环境影响识别　□确定评价指标　□减缓措施

□评价结论和 SEA 报告　□跟踪评价及监督　□其它，请说明：

10　在您参与或了解的评价过程中，公众参与的主体有哪些？（此项为多项选择）

□ 相关领域的专家　□受影响的公众　□NGOs 等　□相关政府部门

11 在您了解的流域规划环评过程中，公众意见被规划编制机关及环评单位采纳的情况如何？（此项为单项选择）

□全部采纳　□部分采纳　□极少采纳　完全不予考虑　□不清楚

12 您认为目前在我国的流域规划环评过程中，制约公众参与效果的主要问题有哪些？（此项为多项选择）

□信息公开不完善

□公众参与制度不健全，缺乏明确、清晰的程序规定

□流域内多数生态敏感区经济、教育水平落后，公众参与规划和环评的能力非常有限

□流域规划及其环境评价过程的专业要求高

□公众参与方式的选择不当

□其它：

13 在第 11 题您选择的几项中，最需要进一步完善的是哪一项？

14 请问在您了解的流域规划环评过程中，评价单位是如何选择的？

□竞标方式　□规划编制部门指定　□规划部门自行评价、编写环评报告

□环保部门指定　□其它，请说明：

15　您认为目前制约中国流域规划环评有效实施的主要问题有哪些？（此项为多项选择）

□指派建设项目环评研究机构进行 PEIA 或者流域规划部门自己做环评

□流域规划环评理论研究欠缺，方法和技术很不成熟

□流域规划中的水资源及生态保护部分与流域规划环评冲突，部分内容重复

□流域内多数生态敏感区经济水平和教育水平落后，公众参与规划和环评的能力非常有限

□流域规划及环境评价信息多数没有公开，严重阻碍流域规划环评的实施和研究

□法律法规不健全，缺乏严格、明确的立法要求

□缺乏清晰、明确的流域规划环评导则和指导办法

□决策背景包括政治、经济和文化背景等阻碍了流域规划环评的有效实施

□水资源、水环境管理体制不健全：流域管理与行政管理之间以及水资源管理部门与环保部门之间的矛盾

□流域规划制定时间过短，环评过程过于仓促，不能充分分析、评价和预测各种环境影响

□其它，请说明：

16 在第 15 题您选择的几项中，最为紧迫的问题是一项？

17 为促进中国流域规划环评的理论研究和有效实践，以下哪些方面亟待深入研究？（此项为多项选择）
☐流域综合管理与决策理论研究
☐水资源、水环境管理体制研究
☐累积影响方法和技术
☐决策背景研究：政治、经济和文化
☐环境承载力分析
☐流域规划环评的实施框架及指标体系研究
☐流域规划环境影响预测方法研究
☐相关立法分析和研究
☐欧盟水框架指令与 SEA 指令相结合的经验分析与对比
☐流域规划环评的不确定性分析
☐其他：请说明：
18 在第 17 题您选择的几项中，最为急需研究的问题是哪一项？
19 您认为您了解的流域环境影响评价是否有效？

☐非常有效 ☐在某种程度上有效 ☐只在很小的程度上有效 ☐无效 ☐不知道

20 在您了解的流域规划环评过程中，主要涉及哪些机构、部门或单位，请您在将涉及的机构或部门编号列在与主要职责对应的表格内（此项为多项选择）

（1） 国务院（2）国家水利部（3）国家环保局（4）流域水利委员会（5）环境科学研究院/所（6）环境评价公司（7）地方环保局（8）水利厅、水利局（9）水利、水电规划设计院（10）水资源科学研究所（11）生态科学研究所（12）国土资源部（13）城市建设部（14）农业部（15）交通部（16）林业部（17）国家发改委（18）遥感研究所 （19）其它，请在对应职责的表格内注明。

拟议流域规划的主管部门：

评价单位：

审批部门：

评审组：

其它部门或机构，请注明：

21 恳请您注明您所经历或了解的涉及流域总体规划或流域专题规划的环境评价案例名称。

22 请问您对该类规划环评在中国的实施和相关研究有哪些建议？

Appendix III List of Interviewees

Interviewee		Position/Title	Organization
B1	Non-structured	Associate Professor	EIA institute
B2		Professor	EIA institute
B3		Associate Professor	Water Research Institute
B4		Director	Water resources Commission
B5		Researcher	EIA institute
B6		Researcher	Environmental Institute
B7	Structured	Researcher	EIA institute
B8		Engineer	EIA institute
B9		Senior Engineer	Environmental Research Institute
B10		Engineer	Environmental Research Institute
B11		EIA actor	Environmental Research Institute
B12			Environmental Research Institute
B13		Director/Professor	River Research Center
B14		Professor	River Research Center
B15		EIA actors	Environmental agency
B16		Director	Environmental agency
B17		Director	Environmental agency
B18		Director	Environmental agency
B19		EIA actor	EIA research institute
B20		Engineer	Environmental research institute
B21		Professor	EIA research Institute
B22		Associate professor	Environmental research institute
B23		Director	Environmental research institute

Appendix IV Questions for Interviews

1.您认为我国的流域规划是否有必要实施环境影响评价？如果有必要实施流域规划环评，那请您谈谈环境影响评价对我国实现请您谈谈流域规划环评的必要性及其作用。

2.您或者贵部门参与编写、审批或者了解的流域规划环评案例主要有哪些？

3.您能否详细介绍您所了解的某个或某些流域规划环评案例：环评参与规划的时间、参与部门、参与过程；主要有哪些阶段及各阶段采用的主要方法和指标；主要有哪些成果（哪些文本）；影响了流域规划的哪些内容或规划过程的哪些方面等等；有无考虑累积环境影响或间接影响？如果是，请具体指出是哪一类的累积影响或叠加影响？ 并说明采用的方法；.公众参与情况（主休及其参与方式；参与内容、反馈情况及有效性；存在问题及原因）。

4.我国的流域规划环评存在的主要问题。 其中,当务之急应该优先解决哪些问题?造成这些问题的主要原因是什么？应该如何解决?

5.目前已经实施或正在实施的流域规划环评是否已对我国实现可持续性的流域管理发挥了应有的作用？如果是，那么主要发挥了哪些积极作用？

6. 2003 环评法实施前后流域规划环评有无明显区别，如果有，主要区别有哪些？当前决策背景下流域规划环评的框架及其指标体系是怎样的？应该如何改进？您对该类规划环评在中国的实施和相关研究有哪些建议？

Appendix V Comments from the Interviewees

B1	Non-structured	大多数普通的环评人员不了解流域规划环评，只有少数与流域管理或者水资源管理相关的环评人员有可能会了解该领域的环评。
B2		他参与的流域规划环评评审，发现所有该类环评报告做的都不好，不符合规范. 环评的人，写论文的，除了一些大学外，可能很难有做环评的写论文，即使写了，也没有什么学术的价值。中国的环评业，重视实践，轻视理论和研究。你要重新查阅一下文献。
B3		很简单，没有环评报告书、只有环评篇章，和其它环境评价一样啊，就是按照那些套路。
B4		认为流域规划环评与流域规划报告的环境保护部分冲突，没必要进行该类环评；他们负责的流域规划环评大部份由海委内部成员或者由他们自己找熟悉的人去做
B5		认为在所有类别的规划中，环保部门与水利部、流域水委的冲突最大、矛盾最难协调。虽然环保部门和土地、交通、城市规划等部门也有冲突，但毕竟这些部门稍有妥协，自己也在努力去做与他们相关的规划环评；而水文水资源管理部门，他们关心的是经济发展和水资源分配，环保不是他们关心的重点。她还提到，有些单位曾经找她及其同事做流域规划环评，但他们不敢接手，担心做不好，影响自己单位的声誉。总之，太难了。
B6		很多流域规划环评都被内部消化掉了，水利水文以及流域管理部门之外的环评机构很难接到该类环评的任务，特别是流域综合规划环评多为流域管理结构相关的环评的单位参与。 环评资料很难拿，有问题也是自己内部的人知道，不想让外边的人了解自己单位的环评水平。流域规划环评的资料一般外人很难拿到，甚至参与过其中部分任务的人也只了解他所参与的部分，而其余部分的资料以及规划、环评文本都拿不到手。
B7	Structured	参加了目前一个大流域综合规划环评的部分技术工作，但他没见过完整的规划报告及环评报告
B8		该流域综合规划环评主要依据江河流域综合规划环评规范（2006）和环评技术导则；关注的问题主要是水资源配置、节水、岸线利用管理规划、河口及海堤规划等 16 个专题规划；

		环评上没有用到模型，主要是宏观、定性评价；采用的环评方法主要是矩阵法，用于分析规划与环境因子的相关关系。 其水保局做的生态修复规划用到水质模型；其结论用于该综合规划。 累积影响应该提，但是在该次规划中由于时间限制和规划方的要求，主要考虑的是直接影响，没有提到间接影响和累积影响 现在修编的流域综合规划与80年代的流域规划已经几乎完全不同。 公众参与：根据环评法和规划环评条例，规划环评报告书必需有公众参与部分，但综合规划只需要环评篇章，不需要编写环评报告书，所以不需要公众参与部分的内容。在这次规划环评过程中，没有普通民众和受益人的参与，主要是省政府部门的参与，比如省环保部门和省发改委等，提意见供参考。最后环评报告书需要上报水利部，再到国务院审批。 环评是在规划中期、好几稿规划报告已经出来的时候介入的 主要问题：规划与环评时间短；可操作性差 环境承载力考虑了，主要是水域的负荷 去年该流域规划环评开始的，打算今年10月底申报水利部，再到国务院，仅用了一年时间 该次环评主要考虑的环境主题包括水环境、水资源、生态、社会经济等四个方面。水环境主要考虑的指标是开发利用率和地下水基本实现采补平衡；水资源主要考虑水功能区水质；生态方面主要考虑生态需水量；社会经济方面主要关注河道防洪问题。 没有后续跟踪，如果评价结果与实际影响出现冲突，才可能会有后续跟踪评价，否则就不再进行后续评价。 由于该流域综合规划环评正在进行过程中，还没有申报，所以不愿意提供资料。但有幸了解到环评篇章的目录内容和环境预测矩阵表。
B9		规划部门可以自己编写环评报告，或者委托环保部门做；规划环评往往是作为政府职能部门的行政任务、专业任务去进行的。规划环评存在的问题很多，首先，规划环评收费很低，很多单位不愿意去做。例如，一个案例中，上千万的规划费用中，只有10万-20万给环评部门或者环评工作人员，经费不足，也是影响这类环评的一个重要因素，很难做细做好。另外，规划

		部门认为环评是可有可无的，而且还限制规划的实施，尤其是水电部门，追求经济效益最大化。 某重点流域的规划环评，从环保角度砍掉了 13 个水电站（50%），是真正的规划环评。 某国家电力研究院，算是比较正规的，但仍然是自己规划，自己环评，立场：拿人钱财，替人消灾。 大盈江水电站规划环评 （机密） 本来应该规划与环评同步，根据初步环评报告，初拟规划报告，但实际上，云南省很多没有做到，甚至简单复制其它文件上的一些内容。 替代方案的选择一般与规划部门商议 现在的环评，被看作是不认真的事情 环评队伍复杂，认真的反而吃亏，花费时间长，市场份额小 文件报告的多少，与项目大小有关，项目大的话，做的相对比较深，专题报告也多 上面制定环评导则的人很多海归派、学究，没有实际工作经验，拍着脑袋想当然的要求别人去做的，制定的导则理论上很完美，但实际上却很难实现，或者根本做不到。例如，在一个案例中，规划单位如果按照导则的话根本没法做好，于是对制定导则的人说，愿意给他 200 万，让制定导则的人去做，但制定导则的人却不知道从何下手了。 CEA 一般都做得不好，在环评方面花费资金较多的案例比如澜沧江的后期评价。 70-80s，主要是计划经济，那时候注重技术探讨，从学术上来说，的确是做了许多事情。 现在，如果环评专家与规划单位领导思路不合的话，会被赶出去。或者下次不被聘用，聘用的多为能为其规划扫平道路的人。 2003 年前后： 2003 年环评法之前，尚没有对规划环评进行单独审查，而到了 2003 年环评法之后，才开始对规划环评进行单独审查的。 在一个案例中，由于环评专家对某规划提出质疑，规划负责人在会议上大发雷霆，国家给你们发展机会，你们还说三道四。 经济、社会、环境的平衡点很难找到 西南地区的流域水电规划环评类似我国其它区域的综合规划，因为该区主要是水电项目，几乎没有其他项目建设。 流域规划环评的公众参与与项目环评不同，公众根本不具备参与规划环评的基本条件，尤其是知识缺乏。环评工作者有时候都不能很好的了解，何况是普通公众。

		环评工作者不能参与后面的过程，不利于思考过去可能存在的问题，因此也很难在以后的类似工作中进一步改进，后评价基本没有。 国际河流：上下游评价标准不同，上游水土保持，下游泥沙来源被截断。
B10		参加过某流域规划环评，中游已经做完，上交环保部，正常情况下应该批复了，但最终的批复还没有出来，主要原因：该保护鱼类（间接影响到鱼类保护区）；累积影响从国内的研究水平来讲，尤其是生态、水环境，没法说清楚。 环境承载力已经半定量化了，但只能是相对有用，面临许多问题。例如，不同的统计部门可能有不同的承载力界定，评价区域的大小也会影响承载力的界定。 国家对流域规划环评重视多了，对此的理解也基本成型。 有许多被否定的案例，而且否定依据充分，但在 03，04 年的话，这种情况不会有 农村地区公众参与：村委会召集，环评人员现场解释，发表格，花很长时间（多数村民不识字；或者不懂） 农民更多关注生计问题、就业、耕地赔偿问题、房屋、灌溉。 初、高中文化的公众，会关注环境、施工期间的噪声、扬尘。 也会访问学校老师
B11		他们虽有丰富的环评经验，但对流域规划环评不了解。他们的同事中有流域规划环评经验的人也很少，尽管这是一家省级环境研究单位
B12		
B13		没有对流域的整体了解，几个大的集团争抢、信息不交换（利益冲突），一人一块，肯定会出问题。 目前尚没有一个成功的流域规划，更不用说流域规划环评，九龙治水，很难综合。 部分电站停下来的原因就是没有进行流域规划环评。 国际河流信息保密（机密），所以很多数据需要自己监测或者从国家部门机构购买。而且注意是依赖购买资料，因为购买的国家统一资料便于对比。 对一些生态后果的分析结果，也是保留性的公开发表。 目前准备进行的项目：划出生态敏感区 工程成本应该包括生态成本；工程效益也应考虑生态效益 工程倾向于千年一遇的设计标准，造成工程浪费 水电开发的评价问题：全世界所有的环评都是单项指标评价，即社会指标，经济指标和环境指标分开评价。 其所在大学目前正致力于流域规划初级模型，将社会指标，经济指标和环境指标综合在一个模型里进行评

		价。 其所在大学研究机构很少参与流域综合规划 规划环评成功案例很少 黄河流域委员会作为一个较为强大的流域管理机构，却很难协调各部门、各行政区之间的关系 即使现在唯一一个流域管理的成功案例，田纳西流域管理，但田纳西与其他流域之间的关系却很难协调。田纳西案例的成功基于非常特殊的背景，其模式虽好，但在其它地方却不适用 澳大利亚：Murray-Darling 流域管理为按流域统一管理水资源提供了一个模式。但其流域综合开发却难以协调，更不要说在中国的现有体制下了。 研究建议：创新，流域综合管理与国家大的机构改革相结合，为了实现可持续性的流域管理，应该怎样协调、管理各方面的关系，怎样进行相应地国家机构改革？ 对于流域综合规划，最大的问题是权利问题
B14		专业：水管理，对此不是很了解。一般是在实施规划前才进行环评。主要是由当地的水利水电勘测设计院及流域水资源保护研究院进行流域规划环评。 SWAT 模型曾在水利规划中使用，主要是进行水量分析，以定性为主。
B15		在多数环评单位，多数年轻的环评工作人员对流域规划环评不太了解，了解该类环评的主要是资历比较深的高层领导者，他们虽然没有实际参与环评报告的编写过程，但由于经常接触各类环评的评审会，因此对此也有些了解。例如，某省环境受理中心的多数环评人员主要关注水利水电项目环评、城市规划环评等，很少人了解流域规划环评。
B16		参与了很多流域规划环评案例，包括 70%的所在省内流域规划环评案例。 认为项目环评和流域规划环评都是必须的：流域规划环评侧重于对流域开发提供政策性的框架和指导；项目环评更加关注具体的改善环境和减缓措施。目前对于流域规划环评和项目环评的区别仍不是很清楚。 流域规划环评是环境政策参与流域管理的重要手段，应该引起足够的重视，而且比项目环评更应得到重视。 北京水规总院有很多案例，做的不错 规划环评包括流域规划环评在内，应该由国家政府出钱，但实际上目前规划环评的资金来源多样，比如由参与水电开发规划的开发企业提供。 流域规划应该考虑 0 方案，做多方案比选，0 方案比选，但实际上目前几乎没有考虑 0 方案 （不开发也是一种方案），考虑的多数是要求开发的方案。

		公众参与很重要，形式多样，应该重点选择以下公众主体：了解、熟悉开发规划的专家、学者等。而不是直接受影响的公众。直接受影响公众的意见不可取，因为在规划阶段很多只是设想，具体哪些项目要实施及其实施时间、地点尚未确定，其影响也难以确定，存在很大的不确定性，而公众的教育水平、参与程度和信息公开程度有限，根本对未知事件没有切身感受和深入理解。在我国的许多老百姓主要为了生存而努力，特别是在流域上游生态敏感区的公众，没有心思关心国家大事和未来环境。 流域规划环评的公众参与和项目环评的公众参与不同，更为复杂、更为困难。 2003 年环评法之后，其所在省的流域规划环评效果还是明显的，否定了一些项目，推动了流域规划的发展。 CEA：大部分做的不好。主要原因包括资金、时间限制和环评单位水平的差异，因此应作基础性的研究。
B17		环保局规划司主要是做流域污染治理规划报告，流域综合规划、防洪规划等由流域管理部门负责。而目前流域污染治理规划不要求进行环评。
B18		流域规划环评环保部没有参与、审批过，主要是水利部及地方有关部门在做，特别是环评法之前。环评法之后，现在进行的流域规划修编报告还没有提交，所以他们也没有看到有关环评的报告等相关文件。
B19		公众参与很难，规划单位或者项目单位不愿意让环评单位开展公共参与，有时候，环评机构也愿意满足委托单位的要求，乐得清闲，只是走走形式，约完成 10 份左右的公众参与问卷，就把剩余的问卷任务由规划单位或建设单位自己完成公众参与问卷的要求。 省环保局负责审批省内的流域规划环评，但是省环保局隶属于省政府，受省政府及省内其它部门的制约，在职能上不是隶属于国家环保部。所以，省环保局的审批意见仍然是以地方利益为主，主要考虑省级决策部门的意见，比如省发改委、省水文局等省级政府部门的意见。如果是在职能上，省环保部门和国家环保局是垂直隶属关系的话，可能会发挥一定的环境监管作用。 现在很多环评单位、甚至包括高校和研究所的环评机构在内，很少进行这方面的研究，主要把环评当作了商业化的项目，当做了赚钱的工具，环评报告已经成了批量生产的产品
B20		流域规划环评基本步骤：在环评之前需要进行规划（了解情况，比如国家的各种规划标准，如生态安全、水利部等的生态需水标准等需要仔细研读；阅读各类文献；具体流域的现状调查，如现场查勘，收集资料，

		其重点在大型工程、生态敏感区，包括生态功能区、人口搬迁等，不可能全部都调查，只是有目的的对重要区域和方面进行调查；整理数据，如果数据不足，可能需要补充调查，如水质观测数据；影响分析与预测）。 相关研究最好是选择目前在该领域比较重要的一个问题或一个方面，并结合 GIS、RS 以及模型等进行分析。比如，整个流域水库的建设前后对水文情势、污染源、水文生态、水动力的影响；流域规划工程对水文（流量、水文流场）的影响；对生态需水的影响；梯级电站建设可能会导致流场全部改变，及对河道纳污能力产生影响。 累积影响（水生态、水质、河道生态、河道纳污能力、水文情势如流量和流场的累积影响）与水动力结合。
B21		评审专家（甚至是没有做过环评的人）用项目环评的要求来评审规划环评，不是真正的规划环评，是项目环评的简单叠加。以九龙江流域综合规划为例，包含 100 多个小水库，洄游鱼类全部消失，自然生态完全破坏，虽然渔业统计产量在逐年增长，但捕捞业已全部消亡。 第一次评审时，九龙江流域综合规划环评报告没有通过，评审专家认为这一环评结果很难实施，必须明确哪些项目污染严重、需要禁止建设；如果按 B21 或其他环评专家的意见，下游项目应该完全去掉，虽然各个项目单独的环境影响不大，但累积影响是无法估量的，可能是在未来才能表现出来的无法恢复的环境影响。在这次规划中，有 100 多个新建电站，它们的累积影响虽然在近期看不出来，但在全部投入使用的数年后将是无法估量的、甚至是无法恢复的，可能的累积影响包括：河口输沙量下降，河口遭到侵蚀，水资源不平衡（本来水库应该在洪水期蓄水、枯水期放水，但各个水库为了各部门、各地方的自身利益，却经常出现汛期放水、枯水期都关水的现象，下游则出现汛期更涝、枯水期更旱、甚至断流的遭遇）。 管理层面的研究是无解的。西方国家对此已经进行了多年研究，但是管理层面上依旧我行我素，没有很大的改进。 公众意见完全不考虑，公众意见对决策是没用的。环评意见也是不被采纳的，省环保局为了便于管理、为了迎合省政府其它部门的意见，一般要求环评专家明确告诉他们哪个项目可以建设、哪些项目必须撤掉，这样对他们而言就足够了，而不是考虑他们的累积影响。这样，完全脱离了战略环评的意义。 Top-down 的管理方式，进行环评的时候，一些项目已

		经开工建设或者已经决定哪些项目必须建设。 环境承载力不容易算、没法算，没有实际意义。 公众参与与后续跟踪非常薄弱。 农民非常反对小水电建设，所有建设项目或所有利用国家资源的企业，都有政府官员的控股，否则这些项目无法审批。因此，即使有严重污染后果的企业或建设项目由于牵扯到地方政府甚至省级政府官员的利益，想关也关不了。 目前的战略环评主要表现为三种形式：项目环评的提升（多数）；决策环评；直接介入决策分析的环评 （厦门湾港口总体规划战略环境评价就是很好的例子，在规划之前就进行了环评，提出哪类项目不能建设，哪些生态敏感区不能建设项目，从而对规划有了一个框架性的指导意见，使得后面的规划不会有原则性的大错误，也是比较理想的战略环评）。 九龙江流域综合规划环评已经作为福建省流域规划环评的范本而使用，但实际上项目负责人自身就对报批稿感到不满意，已经在原来送审稿的基础上删掉了部分有价值的内容，没有真正影响决策；脱离了规划环评的本意。当送审稿提交时，没有通过评审，评审专家认为没法实施，要求明确各个项目的环境后果，明确哪个项目可以留下来；另外，有些项目已经开始了，必须想法证明这些项目可以建设。否则，省环保局可能会遭受其它部门的压力，也会难以立足。 他在相关研究中提到规划的环保原则性保护框架性意见，就是在规划之前，进行环境影响识别和预测，规定不能建设的项目类型和禁止任何开发项目的生态功能区、生态敏感区。 流域规划环评的可操作性很差。 有关国内的环评研究多是纸上谈兵。 环评引进中国已经这么多年，举步不前，相关研究还只是空谈，在理论上仍然没有深入进展。 他还认为现在的战略环评研究没有多大出路了，都是泛泛而谈，没有多大的科学价值，即使在国际上，也没有深入的研究成果。除了 Environmental Impact Assessment review 这一本期刊有很多战略环评的论文，战略环评论文很少在 SCI 论文中出现，Environmental Impact Assessment Review 还不是 SCI 期刊，档次比较低，论文比较浅显。 九龙江流域洄游鱼类的消失和捕捞业的消亡都是过去流域开发造成的负面累积后果。
B22		现在的环评很空，有既定的模式和大纲，相互抄袭的现象非常严重。甚至，有些只是拿其它项目或者其它规划报告的环评报告书做蓝本，只是改改其中的数字

		和名称。 环评结果没有影响决策，在环评之前一些规划的项目已经开工建设。 在研究中，如果作案例分析的话，没有实际参与过可能会比较困难。
B23		现在的公众参与主要是政府部门的代表参与。环评结果成了项目建设和规划实施的通行证，目的是通过审批。