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Ecological Impact Assessment; Conceptual Approach for Better Outcomes

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ABSTRACT: This study aims at evaluating the completeness of the content of the ecological part in Environmental Impact Assessments (EIAs) and Environmental Impact Statements (EISs) on content review basis. The requirements of the ecological content as stated in the of five sets of Thai's EIA guidelines, namely the specific guidelines for power plants, industrial projects, dams and harbors and the general guideline are used as the basis for this research. The main findings are that the requirements of the content of the ecological part in the guidelines differ from one guideline to another and the most different one is the specific guideline for dam projects. Generally, ecosystem, habitat and species population are presented. The guideline specifies the requirements for data presentation more clearly than those for ecological impact assessment. In addition, thirty EISs of power plant projects are systematically reviewed and it is found that there are a number of improper practices of ecological impact assessment process including insufficient baseline study, inconsistent impact interpretation, and ignorance of ecological point of view in setting up mitigation measures and monitoring programs. Ecological content in EIA guidelines and EISs can be shown in a logical sequence of events in order to form an effective system of ecological impact assessment.

Key words: Environmental Impact Assessment, Environmental Impact Statements, Guidelines, Power Plant Projects, Content analysis, Thailand

INTRODUCTION

Environmental Impact Assessments (EIAs) are widely accepted as an effective tool for predicting changes in environmental conditions and setting up environmental management programs and its benefits are well accepted. One of its purposes is to provide sufficient information and justification to enable decision making among various alternatives, based on predictions of potential effects of the project, and to identify ways to reduce and mitigate unacceptable impacts. It forms the baseline of legislation and policy and to support the main initiative toward sustainable development. The EIA process also ensures that environmental and socio-economic issues are identified and addressed throughout the planning and implementation phases of project development (Nasr *et al.*, 2009; Paterson *et al.*, 1993; Gow, 1992; Meredith, 1992; Hyman and Stiftel, 1988).

In Thailand, EIA became in effect in 1981 when the National Environmental Quality Act (NEQA), 1978 was amended. The first notification under this Law was issued on the basis of types and sizes of projects and activities requiring EIAs. Hence, the EIA process in Thailand is legally defined. The most recent amendment of the legislation is embodied within NEQA, 1992. Practically, there are exact steps in the EIA process in Thailand. The Office of the Natural Resources and Environmental Policy and Planning (ONEP) is the agency having full authority in issuing EIA guidelines and EIA review and approval in Thailand. Scoping is of the most importance as it provides clear directions for EIA preparation at the beginning step in the EIA process. The purpose to review the EIA guidelines is to indicate whether all relevant information for an EIA is defined within its guidelines and whether it provides an adequate basis for collecting information required by EIA consultants. The guidelines specify the content and the quality of EISs. Glasson et al. (1999) and Wood (1996) confirmed that the EIA guidelines provide an appropriate direction, not only for preparing EISs by project proponents and EIA consultants, but also for ONEP and relevant parties to review EISs.

In this paper, the guidelines for ecological part are reviewed. This part is one important part in the

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environmental impact study and directly affects the consequence of project development (Termorshuizen *et al.,* 2006; Wegner *et al.,* 2005; Treweek, 1999). Inaccurate ecological study at the project level, in particular, the questions how much ecological details should be fixed into the other environmental components, may create consequent problem at the macro level (Kotwal *et al.,* 2008; Fuller *et al.,* 2007; Morris and Emberton, 2001; Byron, 2000; Wathern, 1999; Treweek, 1999). Thus, researches on ecological aspects are an essential way to integrate approaches appropriately for ecological study in EIAs.

This research aims at ecological aspects in EIAs by considering ecological content in the EIA guidelines and that in EISs. It is the objective of the research to consider whether the EIA guidelines give correct and sufficient direction for EIA studies thus leading to provision of appropriate information for setting up efficient and effective environmental mitigation measures of development projects. The outcome of this research finally forms a conceptual model of ecological impact assessment process as one of cases in tropical countries.

MATERIALS & METHODS

To achieve the objective of this research, content analysis is applied to investigate the ecological content in the guidelines and EISs. Firstly, the content of general and four specific EIA guidelines, namely power plant, dam, industrial and harbor projects are selected for review. Secondly, thirty EISs of power plant projects are also reviewed as this kind of development is believed to cause significant environmental impacts by variety of pollutants, depending on raw materials and processes. Moreover, a number of power plant projects in Thailand have faced public opposition due to fear of serious effects and claiming as lack of transparency and hiding of information.

A number of researches concerning the review of EIS contents were conducted by several experts (for example, McGraph and Bond, 1997; Maquire, 1994; O'Shea, 1994; Lee and Dancey, 1993; Dancey, 1992; Wood *et al.,* 1991). The afore-mentioned researches, however, dealt with reviewing content of EISs, not guidelines. In this research, therefore, the review criteria method which once was employed for EISs is adopted to examine the content of the guidelines.A checklist for evaluating ecological content in the EIA guidelines is developed comprising four categories to be reviewed; namely, existing environmental conditions, impact assessment, mitigation measures and monitoring programs. Each key category is then scored according to the completeness of the content. The scores range from 1-5, where the score of 5 represents the most complete content while the score of 1 represents inadequate or missing content (Table 1). The total score of each guideline is then averaged to reflect the quality of ecological content in each category.

For EISs, the review categories follow those applied to the guidelines. The ecological aspects are divided into species population, habitat, community, ecosystem and bioregion. Owing to the fact that ecological content in each EIS varies from one to another, total score of each ecological category in the parts of existing environmental condition and impact assessment is averaged as the final score. Mitigation measures and monitoring programs for the ecological

Table 1. Criteria indicating level of guidance

Levels	Criteria
5 (Completeness)	Provides very specific criteria related to the particular ecological issues in accordance with criteria setting, no additional information required;
4 (Adequacy)	Provides adequate ecological information or issues established required for EIA study, although some issues need to be supplemented, gaps are only minor;
3 (Satisfaction)	Only provides detail demanded for EIA study, necessary additional information regarding criteria question, is not included in the guidelines;
2 (Inadequacy)	Provides general details, not specific for ecological aspects, there are no criteria related to the ecological requirement in the guidelines;
1 (Deficiency)	Does not provide the necessary information in the particular category.

part are proposed in only a few EISs so the features of program identification are only presented.
The relationship of ecological content between the EIA guidelines and the EISs forms a logical sequence for effectively arranging ecological content in EIAs, as shown in form of a conceptual model of the ecological content in the steps of the EIA study process.

RESULTS & DISCUSSION

The EIA guidelines crucially determine environmental data to be presented in EISs in Thailand. The general guideline together with the four specific guidelines for power plant, dam, industrial and harbor projects are selected for this research because these guidelines can be adjusted and incorporated into large scale projects. In addition, these five guidelines represent most types of the projects requiring EIAs under the Thai law. The checklist is divided into four main items. The criteria which reflect the quality of ecological content are listed in Table 2. along with the description of the EIA guidelines and the criteria using for review.

From reviewing the general and four specific EIA guidelines, the average score of the existing environmental condition is 1.62. Among all these guidelines, the specific guideline for industrial projects obtains the highest score of 1.90; the specific guidelines for power plant and dam projects get slightly lower score of 1.75; while the general guideline and the specific guideline for harbor project receive the lowest score of 1.35. The result shows that all guidelines specify the same scope of study for all environmental components. There is little flexibility in defining the appropriate extent of the study area in accordance to particular ecological condition.

The methodology of ecological study varies with major components, namely ecosystems, habitats, and species population. The guidelines emphasize more on data presentation rather than data collection or interpretation. The guideline does not give sufficient detail in terms of communities when compared with other ecological components.

The requirement in the guidelines for ecological data implies methods for site survey and data collection for the baseline study. However, none of the guidelines gives precise indication to ecological survey and data collection. Further surveys which are necessary to complete the baseline data on some significant ecological components are stated in the specific guidelines for industrial and power plant projects.

Study period or timing of the study for field survey or data collection is not stated. According to Vun and Latiff (1999), these factors are important as they influence data accuracy. Furthermore, all guidelines fail to provide sufficient references and legislation and policy interest. The guidelines themselves are not clear, especially the explanation of ecological definitions required in EISs.

With respect to impact assessment, the results of analysis, as revealed in Table 3, show that the quality of the guidelines in providing the guidelines on assessing ecological impacts. The analysis reveals that almost all guidelines concentrate on impact assessment related to project activities for both construction and operation periods. However, the detail differs from one guideline to another. For example, the specific guidelines for power plant, industrial and harbor projects require that impact assessment be described for each phase of project development. It is clearly stated in the general guideline that impact assessment for the operation period be addressed in case that a construction license is required.

The specific guideline for dam projects gets the highest average score of 2.41. Separate ecosystems namely aquatic and terrestrial ecosystems are indicated which reflect the direction to consider habitat types. It also identifies important ecological components, such as ecosystem process, food chain and alternative effect. For the general guideline and the specific guideline for power plant project, incomplete content (level 2) is found. The specific guideline for harbor project gets the lowest score because there is only a sentence mentioning about impact assessment on biological resources without any clear detailed direction.

It is seen that each guideline implies different outline or structures of ecological description, but concentrating more at local or area level. Only the specific guideline for dam project indicates, but not clearly stated, a regional basis, including areas with specific interest surrounding the project site. In addition, all guidelines fail to address impacts to rare or endangered species.

The specific guideline for dam project highest clearly considers both direct and indirect impacts. However, incremental nature of significant effects of some impacts is missing in all guidelines. Residual impacts after mitigating actions are not mentioned at all. On the whole, both cumulative and residual impacts which are critical are missing and may lead to insufficient content of EIS. In terms of impact magnitude, the guidelines address boundary of impacts by the development differently. Most of the guidelines specify the boundary on specific view. The detail which is applicable to a wide range of impacts varying with the nature of a particular project and its location

Table 2. Analysis of existing study

Criteria	Levels of consideration					
	General guideline	Power plant guideline	Dam guideline	Industrial guideline	Harbor guideline	Average
Set out ecological criteria to characterize baseline boundary	2	2	2	2	3	2.2
Concentration of a flexible boundary	2	2	1	2	1	1.6
Indicative methods of ecosystem study	2	3	3	2	1	2.2
Indicative methods of habitat study	2	2	3	3	2	2.4
Indicative methods of community study	1	2	1	1	1	1.2
Indicative methods of species population study	3	2	2	4	1	2.4
Consideration of the sites for nature conservation	1	1	3	1	2	1.6
Consideration of the factors for planning and conducting ecological survey	1	3	2	4	2	2.4
Recommendation of survey methods for different ecological groups	1	1	1	2	1	1.2
Recommendation of initial site visit	1	1	1	1	1	1.0
Recommendation of temporal coverage of data	1	1	1	1	1	1.0
Recommendation of further surveys for significant ecological issues	1	2	1	3	1	1.6
Set out ecological criteria for defining level of information	1	3	3	2	2	2.2
To include a consensus viewpoint which adequately assess ecological impacts	2	3	3	3	2	2.6
Recommendation of the ways to evaluate baseline data	1	1	2	2	1	1.4
Provision of sufficient references together with appropriate legislation and policy	1	1	1	1	1	1.0
Suggestion of sufficient ecological references	1	1	1	1	1	1.0
Identification of personnel qualifications required for ecological study	1	1	1	1	1	1.0
Specification of the requirement for clear ecological terminology	1	1	1	1	1	1.0
Recommendation of linkage of existing data to impact assessment	1	2	2	1	1	1.4
Average	1.35	1.75	1.75	1.9	1.35	1.62

Table 3. Analysis of impact assessment

Criteria	Levels of consideration					
	General guideline	Power plant guideline	Dam guideline	Industrial guideline	Harbor guideline	Average
Impact considerations broadly cover all potential effects on ecological environment	2	4	3	4	4	3.4
Consideration of direct and indirect impacts	2	3	4	2	1	2.4
Consideration of cumulative and residual impacts	1	1	1	1	1	1.0
Consideration of a wide range of impacts depending on project and its location	1	1	1	1	2	1.2
Consideration of impact magnitude	3	2	3	3	3	2.8
Consideration of impact significance	3	3	3	2	1	2.4
Consideration of quantitative ecological impacts	1	3	4	2	4	2.8
Impact assessment at bioregional level	1	1	2	1	1	1.2
Impact assessment at ecosystem level	2	3	4	2	1	2.4
Impact assessment at habitat level	2	2	4	2	1	2.2
Impact assessment at community level	2	3	2	1	1	1.8
Impact assessment at species population level	3	2	2	2	1	2.0
Impact assessment below species level	1	1	1	1	1	1.0
Impact assessment on rare/endanger species	3	1	1	3	1	1.8
Consideration of other environmental factors	1	3	4	3	1	2.4
Consideration of the precision of assessment	3	1	1	1	1	1.4
Consideration of impact presentation	1	1	1	2	1	1.2
Average	1.88	2.06	2.41	1.94	1.53	1.96

is completely missing from the guidelines. Impact significance is specified only in the specific guidelines for power plant and dam projects. Furthermore the specific guidelines for dam and harbor projects indicate most clearly a requirement for impact assessment both quantitatively and qualitatively, but giving no criteria for evaluating impact significance.

The requirement of ecological impact precision is addressed only in the general guideline which provides certain approach for accurate impact assessment. As to an effective manner of impact presentation, only the specific guideline for industrial projects indicates, though not clear, the structure of impact assessment. No other guidelines provide sufficient detail procedure of ecological impact assessment.

In the following step, mitigation measures of the ecological part are determined. In the guideline, this part is considered essential. The score is presented in Table 4. Averagely, the specific guidelines for industrial and dam projects get the scores of 3.33 and 3.00, respectively, whereas the procedures for mitigation measures in other guidelines are still not clearly stated. Each guideline focuses on different aspects. Ecological mitigation measures are mostly emphasized in the general guideline and the specific guideline for dam project, however, at a moderate score. The general guideline does not cover any individual component, not even ecological mitigation measure, and indicates only general requirements, without any detail. For the specific guideline for dam projects, ecological mitigation measures are required for both terrestrial and aquatic ecosystems with some examples. However, the criteria for these ecological aspects must be tailor-made to fit the type and size of projects and also study areas.

The criteria for evaluating environmental monitoring programs and detailed requirements for monitoring parameters are developed and the results of the evaluation are shown in Table 5.

In all guidelines, it is required that impact assessment and mitigation measures go in line with each other. Justifications on ecological parameters to be monitored are well-defined in the specific guideline for dam projects. Physical, chemical and biological factors are all recommended for aquatic ecosystem and statistical precision in monitoring is also required. For the specific guideline for power plant projects, only the phrase “appropriate biological monitoring” is mentioned, without any further detail. In other guidelines, only general environmental components, not specific ecological parameters, are identified. In conclusion, the general guideline presents the most detail in of monitoring, with a score of 3.10. The specific guidelines for power plant and industrial projects are considered fairly complete and get the same average score. The specific guidelines for dam and harbor projects get the lowest score.

Consideration on ecological baseline information illustrated in EISs, as the product of EIA studies, the study area for ecological study is principally specified. In all studies, ecological survey is conducted once. Ecological details are presented at species level while more complicated issues such as behavior of species and ecological change in relation to other environmental aspects are neglected. Generally, methods for ecological study in the EISs are in line with those in the EIA guidelines.

Average scores of ecological parts on population, habitat, community, ecosystem and bioregion are 2.75,

Table 4. Analysis of mitigation specification

Criteria	Levels of consideration					
	General guideline	Power plant guideline	Dam guideline	Industrial guideline	Harbor guideline	Average
Agreement between impact assessment and mitigation program	3	1	5	4	4	3.4
Consideration of the phases of project	1	4	1	4	1	2.2
Specification of budget, time and implementation	1	3	3	4	1	2.4
Specification of coverage issues	3	2	5	2	2	2.8
Specification of ecological criteria	3	2	3	1	1	2.0
Specification of mitigation structure	1	1	1	5	1	1.8
Average	2	2.17	3	3.33	1.67	2.43

Table 5. Analysis of monitoring specification

Criteria	Levels of consideration					
	General guideline	Power plant guideline	Dam guideline	Industrial guideline	Harbor guideline	Average
Relevance of programs to the results of impact assessment	4	4	3	4	4	3.8
Relevance of programs to mitigation measures	4	4	1	4	4	3.4
Specification of sampling frequency	4	2	3	3	1	2.6
Specification of sampling site	4	2	4	1	1	2.4
Specification of duration of monitoring requirements	4	3	3	1	1	2.4
Consideration on both construction and operational phases	4	2	2	1	1	2.0
Specification of operational costs	1	4	1	4	1	2.2
Specification of manpower and expertise	1	4	1	4	1	2.2
Specification of ecological approaches	2	3	4	2	2	2.6
Specification of monitoring structures	3	1	1	5	1	2.2
Average	3.1	2.9	2.3	2.9	1.7	2.58

2.04, 1.90, 1.93 and 1.67, respectively (Table 6). Information on species population mainly focuses on species types and number, especially for aquatic ecosystem. However, species behavior, such as migratory route, species density, feeding place and breeding area, are omitted.

Quality of information on ecological aspect varies slightly but can be scored as fairly complete. As remarked by Dunster (1992), the importance of ecological data in EISs is that it provides necessary scientific framework to achieve effective and efficient decision-making which is the ultimate aim of EIAs. In the process of EIA study, project description and existing environmental condition are crucial requirements for impact assessment.

According to impact assessment, both impact identification and evaluation are necessary for assessing impact significance. In this research, it is found that 80% of aquatic ecosystem impact assessment and 50% of terrestrial ecosystem impact assessment address impacts in both construction and operation periods during project development. However, only descriptive method is presented in most cases. More complex scientific methods, such as mathematical models, are rarely adopted. The weakness of relying on qualitative terms has been commented by many experts, for example, Lawrence (1993) along with Massam (1988) and Hobbs and Voelker (1978) stated that qualitative method is normally presented as narrative description and obviously concerns with uncertainty in impact assessment. The guidelines do not give instruction for qualitative impact assessment therefore impact significance is not considered. Warner et al. (1997) further argued that reliance on personal judgments, which usually accompany qualitative impact predictions, is not adequate for assessing impacts, particularly in determining whether mitigation measures be required. Moreover, time frame for impacts is normally stated, but output from descriptive methods is normally insufficient to give out this point and raises the question of the completeness of impact assessment.

Focusing ecological issues, overall average scores of ecological impact assessment regarding species population, habitat, community and ecosystem are 1.67, 1.55, 1.75 and 1.44, respectively (Table 7). This is considered unsatisfactory. Unclear criteria to assess impacts of each ecological aspect are weak, and as a consequence, assessment details are undertaken without any rigid guideline. A number of EISs indicates the group of living organisms and potential areas likely to be affected by project activities, not pointing out other ecological features. Ecological impacts are mainly assessed by descriptive manner resulting in very general details of impact significance."Negative and no- impacts" are most frequently encountered as

Table 6. Analysis of ecological baseline studies in EISs

Ecological content	Criteria	Average level of consideration
Species population	To provide the reasons for selection the species	1.74
	To detail the characteristics of species in each habitat	2.18
	To identify the species types both scientific and common names	3.54
	To detail the number of organism in each species	3.75
	To detail specific behavior of species	2.54
	Average	**2.75**
Habitat	To use qualitative method for habitat study	2.27
	To use quantitative method for habitat study	1.70
	To identify types of habitat	2.23
	To explain habitat structures and functions	1.97
	Average	**2.04**
Community	To present the mechanism and behavior of living organism within the same community	1.91
	To detail relationship among different communities in the same habitat	1.87
	To detail community characteristics	1.75
	To identify the types of dominant community	2.06
	Average	**1.90**
Ecosystem	To detail the behavior of living organisms within ecosystem	1.83
	To detail the relationship of living organisms in the areas considered	2.20
	To detail the flow of energy and nutrients through community	1.68
	To detail the process of succession within ecosystem	1.50
	To detail ecosystem patterns	2.12
	To detail specific characteristics of ecosystem	1.62
	To present sufficient data available on the various ecological communities	2.56
	Average	**1.93**
Bioregion	To detail the composition of ecosystem in macro level	1.39
	To detail the characteristics of area of specific interests	1.94
	Average	**1.67**

Table 7. Analysis of ecological impact assessment in EISs

Ecological content	Criteria	Average level of consideration
Species population	- To provide evaluation criteria to assess species population	1.37
	- To assess the loss/increment of species that may be affected	1.64
	- To assess the effect to species behavior	1.85
	- To provide adequate knowledge for affected species	1.83
	Average	**1.67**
Habitat	- To provide evaluation criteria to assess habitat	1.41
	- To identify potential areas for affected impacts	2.48
	- To specify a satisfactory justification made for the habitat area loss through the project	1.43
	- To assess the quantity of any natural habitat that may be lost	1.29
	- To assess habitat fragility	1.30
	- To assess habitat sensitivity	1.36
	- To assess the ability of habitat recovery from disturbance	1.36
	- To provide adequate knowledge for affected habitat	1.75
	Average	**1.55**
Community	- To provide evaluation criteria to assess communities	1.45
	- To assess types of community effected	1.88
	- To assess area of effected communities	1.81
	- To assess community structures in temporal aspect	1.93
	- To provide adequate knowledge for affected communities	1.69
	Average	**1.75**
Ecosystem	- To provide evaluation criteria to assess ecosystem	1.19
	- To assess any potentially critical ecosystem factors that may be affected	1.56
	- To provide adequate knowledge for affected ecosystem	1.57
	Average	**1.44**

the output of impact prediction in many EISs. However, bias is often evident in the impact description; "negligibly negative impacts" frequently appear. This is exacerbated by bias on the assessor side.

There are two remarks which affect the output of impact assessment. Firstly, many impact predictions cannot guarantee that adverse effects from project activities will actually occur, because of constraints in impact prediction methods and the ability to determine impact magnitude. Secondly, the mitigation and monitoring actions may result in difficulty to measure the accuracy of impact prediction, since results of impact assessment are not incorporated in preparation of mitigation measures. These constraints are predominantly resulted from the inconsistent ecological aspects recommended in various guidelines. As in the assumption, accuracy of impact assessment is essential and necessary for setting up mitigation measures and monitoring programs (Leu *et al.*, 1996 and Wathern *et al.*, 1988).

According to mitigation identification, three-fifth of the EISs, investigated in this research, define ecological mitigation measures. A number of mitigation measures covered both construction and operation periods of project development. Engineering works, policy making and planning controls frequently affect mitigation identification. Those are the good sides of mitigation measures. On the other hand, mitigation measures to minimize adverse ecological impacts are not efficient since most EISs concentrate mainly on the other environmental components, especially surface water, but not for ecological issue. Although mitigation measures in EISs are in the right format, ecological mitigation measures are still doubtful.

In this research, it is clear that ecological monitoring programs are defined only in a few EISs. The monitoring programs mostly cover both construction and operation periods. Usually, parameters to be monitored, monitoring frequencies and locations are clearly identified. However, time span over which data should be collected in monitoring programs is not indicated. The monitoring programs are a major factor that affects costs of monitoring and project impact control which is under the responsibility of the project proponent.

The main factor affecting monitoring programs in the EISs is the mistake in report preparation when monitoring programs are copy-and-paste from previous EISs of other projects of the same type. This results in very general monitoring programs rather than a tailor-made to a particular project. The effectiveness of mitigation measures and monitoring programs, all presented in EISs, is not guaranteed at all. This is because significant ecological aspects for each power plant are not considered in the impact assessment.

Both mitigation measures and monitoring programs affect the outcome of EISs in terms of conditions of approval. If EISs are to continue to serve their original purpose of being a decision-making document, the details in EISs, especially mitigation measures and monitoring programs, should be more described and well-documented. It is recognized that the guidelines should not only provide advice on EIA preparation, but also identify major issues which facilitate subsequent decision-making based on the EISs.

CONCLUSION

The results of the review of ecological aspects in the guidelines and in the content of EISs in this study are the drive to develop an ecological conceptual model in EIAs in Thailand, as shown in Fig. 1. in form of flowchart in which all steps of EIA process incorporated. It is also developed under two basic factors. The first is the principle of ecological theory and the other is the actual information from the content analysis of this research. The main structure of this model indicates the effect of EIA guidelines which affect the final outcome of EIA, namely EISs, as the only tangible output from the process. Furthermore, external factors which affect quality in each step of EIA study are also indicated in the model. The results of the content analysis strongly confirm that the clear criteria indicated in the guidelines are of greatest significance. Relationships between various elements of content concern the flow of ecological components between phases of an EIA. This aspect affects the outcome of EISs in terms of conditions of approval. In addition, the ecological aspects shall be incorporated. At the same time, they should be considered at all steps in the EIA study in a coherent manner. Thus, the significant ecological components which are stated in the existing environmental description should also be considered in impact assessment. Where the results of impact assessment indicate that a component would receive adverse effects, mitigation measures and monitoring programs should be defined as well. More importantly, completeness of baseline data, precision of assessment, and clarity of mitigation and monitoring specification are all factors concerning the quality of the EISs. The factors which lead to the achievements are also shown in the model.

A logical sequence of events and activities in the model illustrates that successful performance of the factors at one step is necessary for success of the next step and, ultimately, for project implementation, that is an ultimate outcome of EIAs. The model developed in this research illustrates an overall picture of ecological impact assessment. It should be recognized that this model is derived from the results of this research, under current situation. Hence, it is possible to be developed and adjusted at any time when further findings are found.

The results of this research clearly show that ecological aspects in the EIA guidelines provide an initial step in data collection of ecological aspect in EISs. This research recommends the feature required for ecological input in EIA scoping guideline, using the power plants in Thailand as the case studies. If it is possible to adopt them into formal EIA scoping, their beneficial outcomes will directly enhance EISs quality for efficient and effective environmental management of proposed projects in a long term. Significantly, these benefits are not only particular to natural resources and environment at the project basis, but also at the national, regional and global levels as well.

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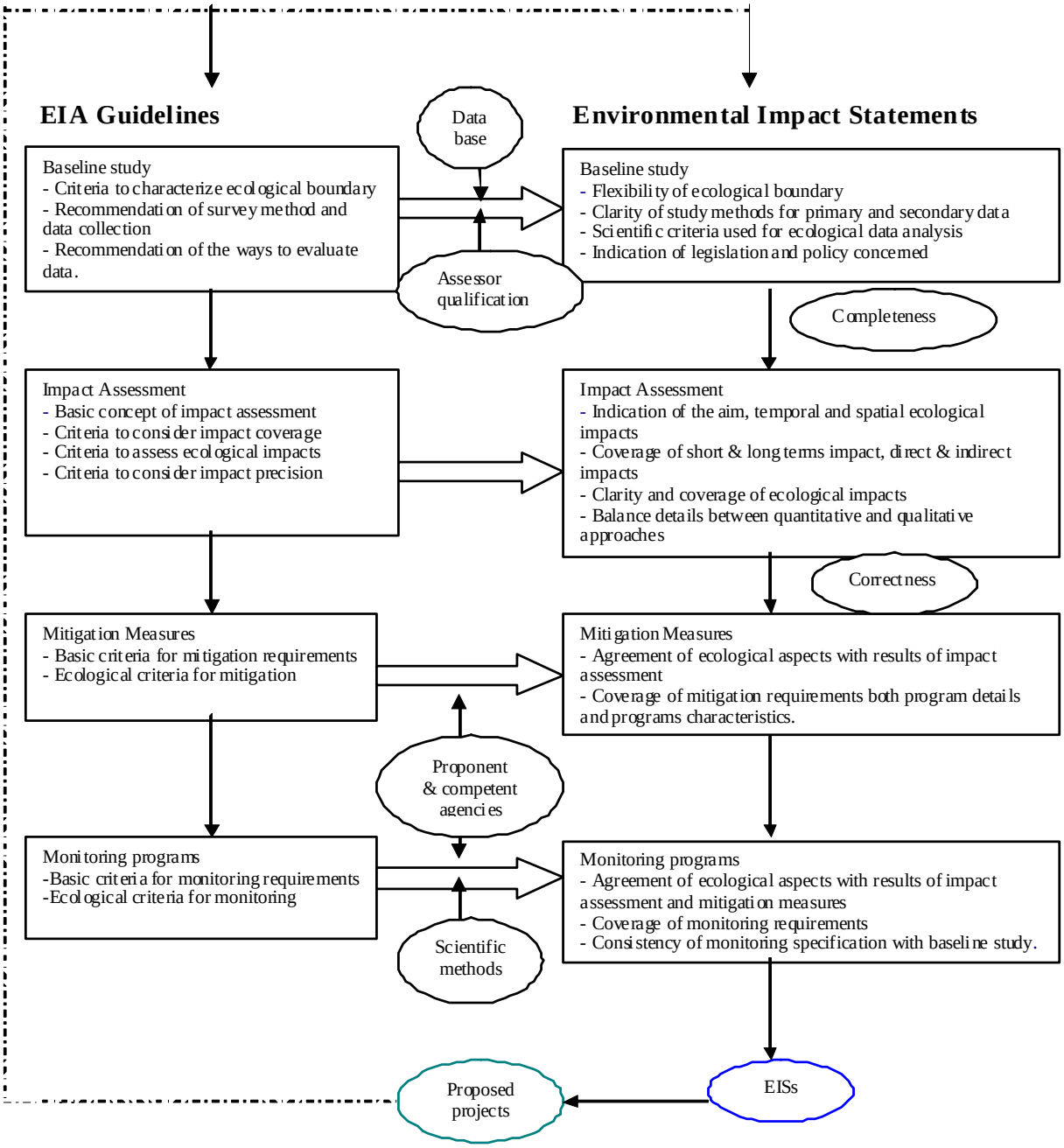

Fig. 1. Ecological conceptual model in Environmental Impact Assessment

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