ASSESSMENT OF ENVIRONMENTAL FLOW REQUIREMENTS IN THA CHIN RIVER: PEOPLE'S PERSPECTIVE

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ABSTRACT

Now a day all over the world, environmental flows are being assessed for an increasing number of rivers. There has been a progressive evolution of methodologies, ranging from simple hydrological indices to complex, holistic procedures for assessing the Environmental Flow Requirements (EFR's) of riverine ecosystems, in which not only the ecological water needs are assessed, yet where also the local demands of human communities along the river are taken into account. In water allocation decision-making process, the interests of the people living along the rivers are often neglected (Meijer, 2003). Possible reasons for this could be that these people live spread over a large area, do not form one well-organized group, live far downstream of diversion structures, or have requirements that are diffuse, intangible or difficult to quantify. Different groups of people will experience different positive or negative effects resulting from flow regime changes. To make well-founded equitable decisions in water allocation it is necessary to consider these aspects. Environmental flow assessment methods can contribute to this.

In order to provide an integrated assessment of the suitability of environmental flows to safeguard downstream ecosystems and services, this paper presents a methodology deals on human well being, river functions and their relation with river flow based in Asian environment. This paper describes an analytical framework for assessing the relationship between group of people and the river flow regime, in order to able to determine flow requirements from people perspectives. The near absence of such methods represents a serious gap in the field of Environmental Flow Requirements. By the by, it is clear that environmental flow ensures ecosystem sustainability which provides better services to the human well being.

1. INTRODUCTION

River water flowing into the sea has for a long time been regarded a waste of water. By constructing dams and weirs and abstracting water, man tried to exploit the river mainly for economical purposes. During the middle of the last century people became aware of the fact that these interventions in the river flow regime have important negative ecological and social effects in the downstream riverine and coastal areas.

The practice of EFR's began as a commitment to ensuring a 'minimum flow' in the river, often arbitrarily fixed at 10% of the mean annual runoff (World Commission on Dams, 2000). But more and more scientific evidence and experience is available that questions the 'minimum flow' approach and there is now a general opinion that for safeguarding essential downstream environmental conditions the dynamics of the river flow should be taken into account. Several EFA methods have been developed over the years that acknowledge the complexity of the flow-environment relationship. This raises the question which method is appropriate in a certain context. Some methods are quantitative by nature (hydrological and hydraulic methods). They determine environmental flows based on flow records. These methods, however, leave largely implicit the river-ecosystem functions for which these flows are required. In other words the method is not transparent[2]. Other methods (holistic methods) try to include all functions of the river-ecosystem, but are usually based on expert judgment and are therefore difficult to reproduce. Hence, there is not one method that comprises all river-ecosystem functions in a quantitative way with explicit and scientifically justified links between the functions and required flows.

In water allocation decision-making the interests of the people living along the rivers are often neglected. Possible reasons for this could be that these people live spread over a large area, do not form one well-organized group, live far downstream of diversion structures, or have requirements that are diffuse, intangible or difficult to quantify. Different groups of people will experience different positive or negative effects resulting from flow regime changes. To make well-founded equitable decisions in water allocation it is necessary to take these aspects into account. Environmental flow assessment methods can contribute to this.

People living along rivers depend for their livelihood to various degrees on functions of the river ecosystem and, since river flow is an important parameter in the functioning of river ecosystems, these people are thus affected by changes in the flow regime. To make equitable decisions in river basin management insight is required in the relationship between river flows and the livelihood of people living along rivers. To take this information into account in water allocation, this relationship should preferably be [1]differentiated, [2]transparent. Environmental Flow Assessment methods developed to assess flow requirements do not provide this relationship between river flows and livelihood in a differentiated, transparent way. However, only a few approaches have any potential for assessment of the water requirements for non flowing aquatic systems, such as flood plains, wetlands, including estuaries, and lakes, and for local human livelihood. The near absence of such methods represents a serious gap in the field of EFR's as one of the least developed fields in EFR is the way to assess and express the needs and requirements of local people living downstream.

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[1] Taking into account the different requirements of distinguished groups of people. Provide a method to distinguish between uses and priorities of groups, which may be affected in different ways.
[2] Provides transparent relations between the lives of people and the river flow requirements.
Both ways may contribute to taking the interests of local communities into account in river management.

River functions are defined as goods or services that satisfy human needs derived directly or indirectly from the river ecosystem. The goods and services include not only harvestable products but also refers to other benefits of natural processes (i.e. the services), such as the capacity to recycle waste. The generic lists of river function are shown in Table 1.

Table 1: Generic Lists of River Functions
(Source: http://www.library.delftcluster.nl/pdf-files/DC1-624-4.pdf.)

Carrier Functions	Production Functions	Regulation Functions	Information Functions
• navigation and transport • river bank occupation • coastline stabilization and delta formation	• water supply (industrial/domestic) • hydropower generation • agriculture • fisheries • hunting and gathering • forestry	• purification capacity • flood mitigation • health • moderation of salt intrusion • hydrological cycle • estuarine and lagoon integrity	• gene pool • tourism and recreation

Of these functions we are interested only in those which depend on the flow regime. This paper presents a framework for analyzing these relationships between people, river functions and river flow regime. It also shows some results of applying the framework on the Tha Chin River in Thailand.

2. ANALYTICAL FRAMEWORK

Current methods often focus on ecosystem characteristics, which do not necessarily relate to the livelihood of people. To consider livelihood in the assessment of environmental flow requirements, insight is required in what functions the river ecosystem has for the lives of people. This can be different for different groups of people; fish, for example, may form the main income to fishermen, but may also form the main source of protein in the daily diet of an entire village.

Few EFA methods consider livelihood, and the ones that do, neglect the importance of explicitly distinguishing the different functions for different groups of people and do not provide transparent relationships between livelihood and river flows.

A conceptual model for relating livelihood to river flows has been developed based on literature research to determine the Environmental Flow Requirement and it has been tested in a case study.

Relationship between the river-ecosystem functions and the lives of people living along the rivers

The socio-economic value of a good or service depends on the way it contributes to human welfare (De Groot, 1992). Different groups of people may have different understandings about what they consider human welfare, and may also use different functions to contribute to their own welfare.

Consequently, the first step must be to identify different groups of people living along a river. Groups of people can be distinguished by, for example, main income source, geographical location, or gender. Subsequently, indicators need to be defined for the concept of “human welfare” or “livelihood”, which can e.g. be related to health, income, or food. In relating these livelihood indicators to groups of people, different priorities of different groups have to be considered. Moreover, the link between the defined indicators and the functions of the river ecosystem can vary for each group as well.

Relationship between the river-ecosystem functions and the river flow regime

Most of the functions are related to the river flow regime. However, this relationship can take on many different forms. The river can function as a condition or as a resource. The use of the river ecosystem by humans can be direct: for drinking, cooking, or washing, or by navigating the river; but can also be indirect: by the use of river-dependent plants and animals. The direct use can be split in use of the river channel and of related water bodies. Each of these types of use has its own requirements in terms of water discharge, depth, or velocity. Therefore, to understand what process and parameter of the river flow regime as well as environmental flow regime is important to maintain a certain use of river ecosystem functions, insight is required in the type of use of the river ecosystem.

Taking these relationships into account, the framework can be depicted in detail in Figure 2.1.

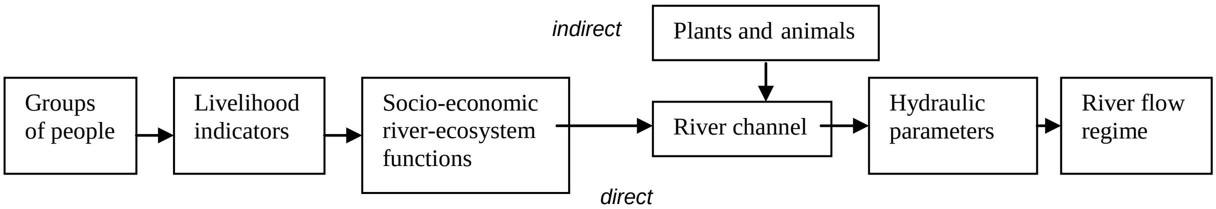

Figure 2.1: Preliminary Conceptual Model for the Relationship between Groups of People and the River Flow Regime (adopted from Klijn, 1994)

Notice that the sequence of the flocks is turned right side to emphasize the fact that we start from well being going right to the requirements for river flows. Moreover, the groups of people have been added to the diagram. Albeit not part of the casual chain, the groups of people have been added to remember that composition of well-being and relationship with the river ecosystem depends on the groups of people considered.

3. RESULTS OF APPLICATION OF FRAMEWORK IN THA CHIN RIVER: A CASE STUDY

The relationship between in stream river-ecosystem functions and the livelihood of people living along rivers was identified based on the case studies. A combination of methods (interviews, observation) has been applied to assess what product and services the people along the river use and in what way these functions contribute to their well-being (stakeholders) as the environmental flow relates better ecosystems provides many products and services to the well-being. A sample has shown in Appendix A to show what information's might have to be obtained from the field. To identify stakeholders from different functions it is required to note that a function may have a different meaning to different people. Navigation, for example, can serve several purposes: income for the people transporting, communications with others areas for local communities etc.

Finally assessing the well-being features and river products and functions in a case study, flow requirements have been performed from people's perspective.

3.1 Study Area

The Tha Chin River is located in central Thailand. Its watershed is connected to the Chao Phraya River Basin to the east, and the Mao Klong River Basin and the Khawe Yai River Basin to the west. The Tha Chin River is the major branch of the Chao Phrya River, and is subject to frequent flooding. The drainage basin of Tha Thin River covers 11,942 km^2, with a maximum elevation of 1,475 m above mean sea level (MSL).The watershed is located in the Northwest of the Chainat and Utahi Tahnai Provinces and the southwest of the Kawanchanaburi Province. They are parts of the Tha Chin highland.

The Tha Chin River has been subdivided into three sections: lower (0 to 82 km), middle (82 to 202 km) and upper (202 to 325 km) based on the river water quality standard and its classification as BOD and DO have been taken indicators. Based on three sections, it has tried to find out EFR's among the relationships of river ecosystem functions, groups of people and river flow regime.

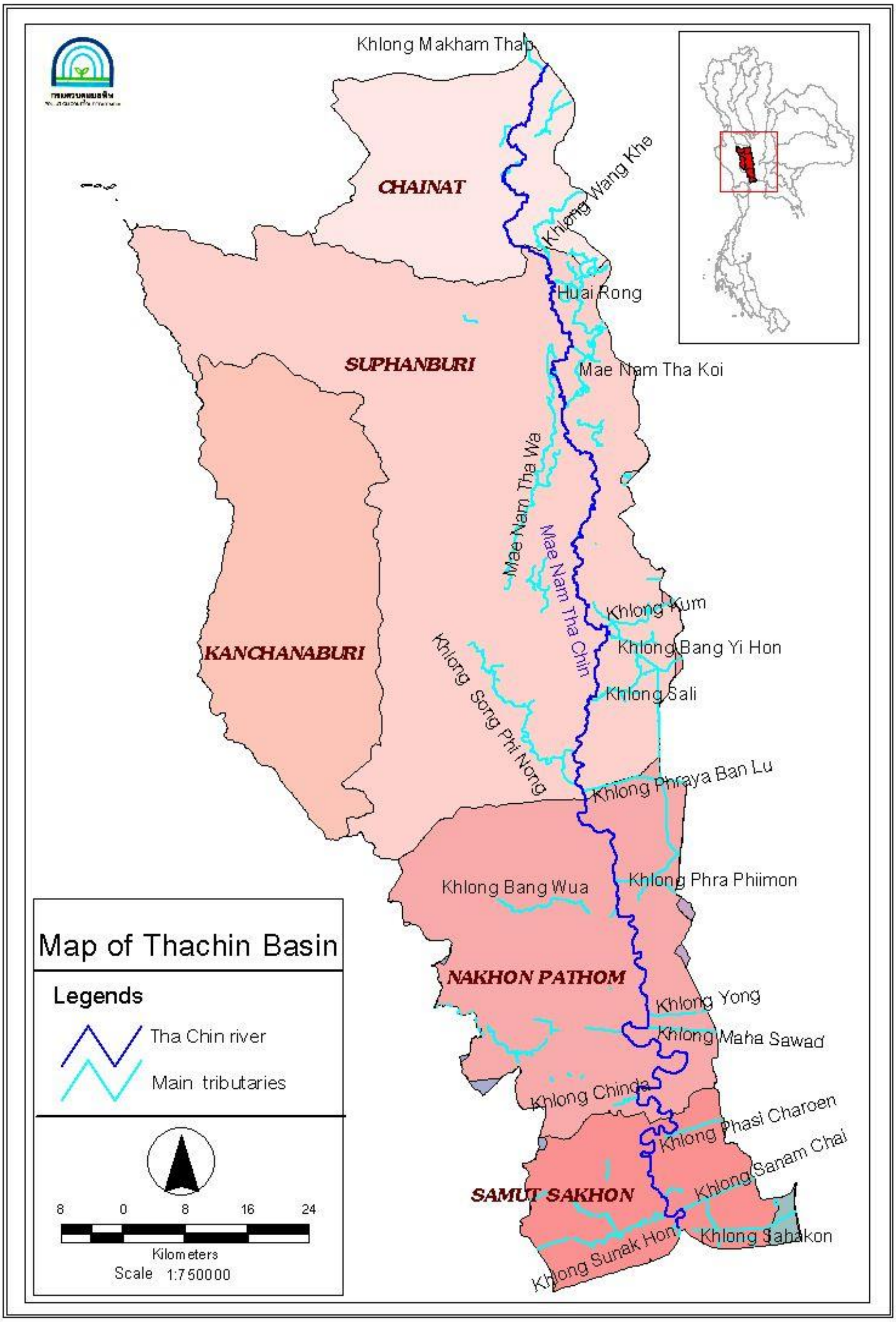

Figure 3.1: Study area (Pollution Control Department)

Table 3.1: The Most Alarming Water Quality Parameter of the Tha Chin River 1994-2004 (Source: Simachaya, 2003)

	DO	BOD
River Reaches	Average	Average
Lower(0-82)km	1.04	2.87
Middle (82-202)km	2.22	2.19
Upper(202-320)km	4.69	1.52

It can be seen from the table that the lower reaches exist a severe water quality problem.

For EFR the full range of the river dynamic should be taken in consideration, which can be described in four classes: annual flow variability, seasonality, extreme events and smoothness. The full range of river flow dynamics needs to be incorporated in EFR's in which four classes of flow parameters and their variability could be used. Linking these flow parameters with ecosystem integrity and sustainability is essential when assessing an environmental flow for a river. The rationale behind this division into four river regime classes is the fact that river functions put different types of demands to the discharge regime. Some functions are only dependent on annual flows, while other depends on seasonal differences in flow.

Table 3.2: A proposed Framework for Defining Key Flow Parameters
(Source: http://www.library.tudelft.nl/delftcluster/PDF-files/DC1-624-4.)

Flow characteristic class	**Description**	**Parameter class**	**Example parameter**
I. Annual flow variability	A measure of overall water availability in riverine systems	Magnitude of annual flow	• Mean Annual Flow MAF • Median annual flow
II. Seasonality	A measure of distinct seasonal differences in discharge, usually related to climatic factors in the catchments	Magnitude and timing of mean monthly flows	• Mean value of each calendar month
III. Extreme water condition	A measure of maximum and minimum discharges with different probabilities	Magnitude, timing and duration of extreme flows	• Value of annual 1-day maximum • Daily exceed for 10 cm depth flow
IV. Smoothness	A measure of reversals in the rise and fall of discharges	Frequency and duration of pulses and rates of change	• High pulses each Year • Rises & falls

The rationale behind this division into four river regime classes is the fact that river functions put different types of demands to the discharge regime.

As not all river functions are equally dependent on the river characteristics, it is important to identify the relationship between flow class and river function. Thus a quick reference can be made with respect to the relevancy of each flow class in case an environmental flow requirement is to be assessed. Table 3.3 provides a listing of the major river functions, their performance indicator and their most relevant (key) environmental parameters and flow class.

Table 3.3: List of Major River Functions and their Performance Indicators
(Source: Marchand, M., 2003).

Function	Performance indicator	Key environmental parameters	Key flow class
1. navigation and transport	number of days per year below a certain water depth	water depth (Q-h relationship); long term morphological changes due to large scouring floods that occur less often than once a year	III. extreme events
2. riverbank occupation	length and severity of eroding banks; annual rate of surface area eroded/accreted	morphological dynamics due to large scouring floods that occur once a year or less	III. extreme events IV. smoothness
3. drinking/ industrial water	number of days per year below a certain water depth	water depth (Q-h relationship)	III. extreme events
4. water for washing/ bathing	number of days per year with zero flows		III. extreme events
5. river fisheries	fishing yield	fish recruitment as function of flooding extent and quality of flood	II. seasonality III. extreme events IV. smoothness
6. hunting	wildlife carrying capacity	habitat for wildlife as function of floods and flow variability	II. seasonality IV. smoothness
7. purification capacity / water quality	WQ standards	- dilution and flushing - quality of water - purification capacity of floodplains and wetlands as function of vegetation growth - suspended sediment transport	all classes
8. health	prevalence of diseases flooding casualties	habitat conditions for vector organisms extreme and unexpected flooding	III. extreme events IV. smoothness
9. gene pool	biodiversity	diverse habitats as function of low flows, floods and flow variability	all classes
10. tourism & recreation	landscape amenity biodiversity (see nature conservation) sailing opportunities (see navigation) sports fishing (see fishery)	relating to many other functions such as nature conservation, fishery, forestry, hunting, water quality, health etc.	see other related functions

Assessing the major river functions, their performance indicator and their most relevant (key) environmental parameters and flow classes in a case study is used in order to determine flow requirements.

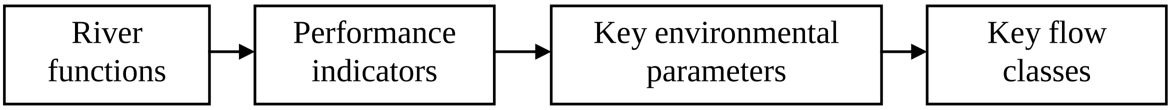

Figure 3.2: Relation River functions with key Hydrological Parameters and Flow Dynamic Class

CONCLUSION AND DISCUSSION

This paper has described an analytical framework for revealing the relationships between stakeholders and the river flow regime. It has been tried to consider groups of people into account when assessing EFR's. The current approach for assessing functions of the river ecosystem is top down. This paper argues that in addition an approach is required which starts at the stakeholders. The case study along the Tha chin river showed indeed that people made use of more river products and services than the top down approach revealed. Moreover, insight has been obtained in the way the river products and services contribute to the people well being.

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