CONSIDERING PEOPLE'S WELL-BEING IN THE ASSESSMENT OF ENVIRONMENTAL FLOW REQUIREMENTS

S. MEIJER Karen

Delft University of Technology, Faculty of Civil Engineering and Geosciences, Department of Water Management. PO Box 5048, 2600 GA Delft, The Netherlands. k.meijer@citg.tudelft.nl

ABSTRACT

Healthy ecosystems are vital to rural livelihoods is the conclusion of research in developing countries (IUCN, 2003). These findings may be used as an argument to claim water for nature in river basin water allocations. But how much water is required, and when? To answer these questions Environmental Flow Assessment methods, which are being developed since the 1950's to assess what part of the flow should remain in the river, may be used. However, current methods often focus on nature conservation in general or, at the opposite, consider only a few animal or plant species. The importance of functions of the river ecosystem to people is hardly ever explicitly addressed. And if, then often based on expert judgement, instead of providing unambiguous quantified relationships.

The research described in this paper provides an analytical framework for assessing the relationship between peoples' well-being and the river flow regime, in order to be able to determine quantitative flow requirements from a peoples' perspective.

1 INTRODUCTION

River water flowing into the sea has, for a long time, been regarded a waste of water. Through the construction of dams and weirs and by abstracting water, man has tried to prevent this outflow of water and to use it for various purposes. Around the middle of the previous century, however, 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. They realised that some water needed to remain in the river. But how much?

Environmental Flow Assessment (EFA) methods have been developed to assess what part of the original flow regime of a river needs to be maintained in the river in order to sustain specified valued features of the river ecosystem (King *et. al*, 1999). This part of the flow regime is often referred to as Environmental Flow Requirement (EFR).

Different types of methods were invented; some relating hydrological parameters to nature conservation in general (hydrological methods), others focussing on specific animal species and their habitats (hydraulic rating methods, habitat-simulation methods). A fourth type of methods, called holistic methods, tries to assess the requirements of all aspects of the river ecosystem. The assessments in these methods are, however, based on expert judgement, which is why they are also referred to as discussion-based methods.

In most of these methods one step is missing; an analysis of what actually are the important functions of the river that need to be sustained. What are the 'specified valued features' of the river ecosystem? As De Groot (R.S de Groot, 1992) argues the value the river ecosystem depends on the way the functions of the river ecosystem contribute to the well-being of people. The answer to this question, therefore, lies in analysis of the relationship between the river ecosystem and the people.

Moreover, people in rural communities depend on the river ecosystem for their livelihood. Focussing on a general concept of nature conservation or on specific species, may fail to provide the river flows required to maintain the parts of the ecosystem the, often poor, people living along rivers in rural areas use to sustain their livelihoods and well-being.

We have, therefore, undertaken research on how to consider stakeholders' interests in EFA methods and in river basin management. For any of these methods it is at first necessary to understand the different dependencies of people on products and services provided to them by the river ecosystem. This analysis we start at the well-being of the stakeholders. However, well-being is not one unambiguous variable; it consists of various aspects, valued and combined into a perception of well-being in different ways by different (groups of) people. In this research, we are interested in those aspects of well-being which relate to functions provided by the river ecosystem.

The functions of the river ecosystem consist of all products and services originating from the river ecosystem, which is defined as all components of the landscape that are directly linked to that river and all their life forms, including the source area, the channel from source to sea, riparian areas, the water in the channel and its physical and chemical nature, associated groundwater in channel and bank areas, wetlands linked either through surface of sub-surface water, floodplains, the estuary, and the near-shore marine ecosystem if this is clearly dependent on freshwater inputs (King *et al.*, 1999).

Of these functions we are interested only in those which depend on the flow regime. Ecological research, however, has shown that virtually all functions of the river ecosystem have some dependency on the flow regime in the river (King *et al.,* 2000).

This paper presents a framework for analysing these relationships between people and the river flow regime. It also shows some results of applying the framework on the Teesta River in Bangladesh.

2 ANALYTICAL FRAMEWORK

The framework described in this section is based on the Problem-in-Context (PiC) framework developed by De Groot (1998) for analysis of environmental problems. In this framework causal relationships are identified between activities which provoke a certain change in the environment which impacts again on another part of the environment, and which finally, through a chain of effects, has an effect on a variable, the change of which one is interested in (Fig. 1a). This variable we call in this research the stake variable. What is analysed in this, following the arrows in Fig. 1a in downward direction, is called a causal chain of effects. However, in this research we want to follow the chain in the other direction; we are interested in what river flow regime is required to sustain a certain state of the stake variable. We, therefore, follow a normative or standard-setting chain, which we start at the stake variable.

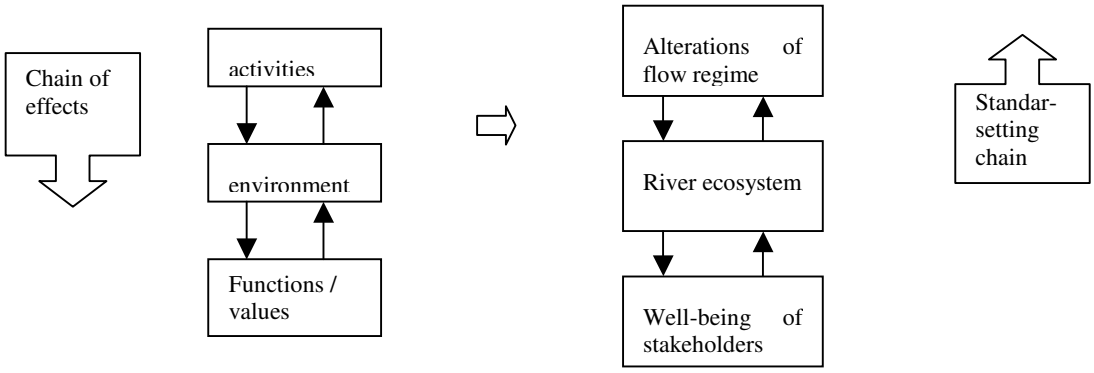

Figure 1. a. Causal chains of PiC framework. b. Application of this framework for this research.

In our standard-setting chain the variable tot start at is the well-being of all stakeholders. Stakeholders can be defined as those people whose well-being is in one way or another related to flow-regime-dependent functions of the river ecosystem. This is illustrated in the diagram in Fig. 1b. For their well-being stakeholders make use of functions of the river ecosystem. The functions are in turn dependent on the flow regime. Measures which alter the river flow regime can therefore be considered the activities which impact upon the environment, which is in our case the river ecosystem.

2.1 Relationship between well-being and the river flow regime

It is not always possible to identify a direct link between aspects of well-being and a river flow regime. For example, people may hunt waterfowl, the availability of which may depend on the amount of fish available, which may depend on the interaction between floodplains and main channel for which discharge is the main parameter. This is why the framework consists of a chain of causal relationships.

This causal chain consists of two distinguished parts: (1) the relationship between well-being and the river ecosystem and (2) the relationship between the river ecosystem and the river flow regime.

To start with the latter, this relationship is formed by relationships between flora, fauna and hydraulic parameters. Although in practice these relationships may be hard to assess, in theory these are unambiguous relationships. Ecological research is required for this, which is beyond the scope of the analysis in this research. However, when available, ecological relationships will be used. The network of interrelationships between different parts of the river ecosystem is not analysed in this research. What is made explicit is the part of the ecosystem directly used by the people. This part of the ecosystem will have a relationship with the local river flow regime, either directly or through the ecosystem network. The local river flow regime is considered part of the local ecosystem. For management purposes the requirements with respect to this local flow regime need to be translated into a river flow regime requirement at some point along the river where management measures can be taken.

The first part of the chain consists of the relationship between well-being and the functions of the river-ecosystem. Those relationships are less unambiguous. Three aspects need to receive attention when assessing these relationships: First, there is no clear definition of what well-being comprises. A number of parameters, such as income, food, health, will constitute a certain sense of well-being. Different stakeholders may hold different perceptions about what is important to their well being. Second, to contribute to their perceived well-being people may make use of different products or services of the river ecosystem. For example, some people

may obtain an income from farming, while others practise fishing. Approaching this from the side of the function, it may mean that a certain product, e.g. fish, may serve as an income to some and as part of their diet to others. A third aspect in assessing the importance of a certain river-ecosystem function for a person's well-being is the availability of alternatives. For example, if river water is used for bathing, but groundwater pumps are available as well, a zero discharge may have a different effects on a person's well-being than if river water was the only available fresh water source. If different sources are available, it may be interesting to understand people's preferences. For example, some people may prefer river water for bathing because the river water is close to their homes, while others prefer water from a pond, because they consider the river water to be dirty. Distinguishing between the different available and preferred sources is necessary, since they will result in different requirements to the flow regime, in terms of flow regime characteristics as well as in terms of the urge of the requirement.

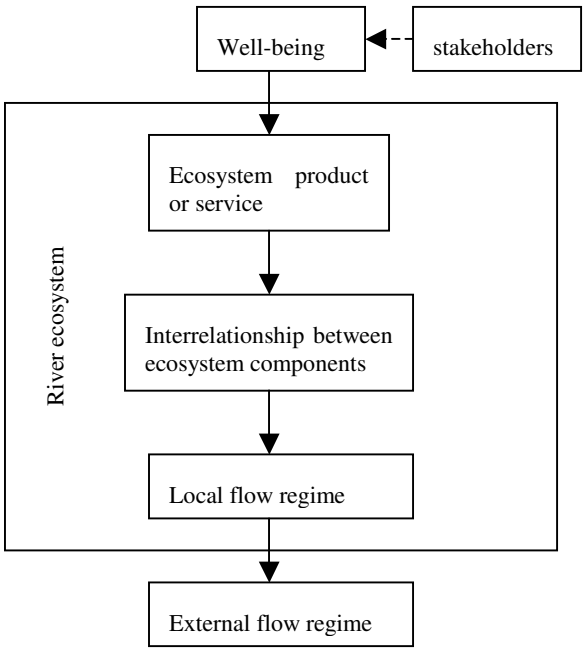

Figure 2. Elaborated framework relating well-being to the river flow regime

Based on the analysis above, the framework of Fig.1b can be depicted in more detail, which is shown in Fig 2. Notice that the sequence of the flocks is turned upside down to emphasise the fact that we start from well-being going down to the requirements for river flows. Moreover, the stakeholders have been added to the diagram. Although not part of the causal chain, the stakeholders have been added to remember that composition of well-being and relationship with the river ecosystem depends on the stakeholder considered.

2.2 Identifying stakeholders and functions

Before the relationships described above can be assessed it is necessary to know who are the stakeholders and what parts of the ecosystem they use. Identifying both the stakeholders and the functions of the river will probably be an interative process. Authorities may mention the main functions the river ecosystem has in their perception, which leads to certain stakeholders. Conversation with stakeholders may reveal other functions, which may lead to different stakeholders, who in turn reveal even other functions, etcetera.

Knowledge of potential functions of water and nature, and literature about multiple use of water and the relation between water and poverty alleviation also provide indications on who may be stakeholders. On functions of water and nature much research has been carried out. Many researchers tried to make classifications meant to comprise all possible functions. A classification often referred to is the one by Van der Maarel and Dauvelier (1978, in De Groot, R.S., 1992). They distinguish four categories of functions: carrier functions, production functions, regulation functions, and information functions. Fig. 3 clarifies the meaning of these four categories.

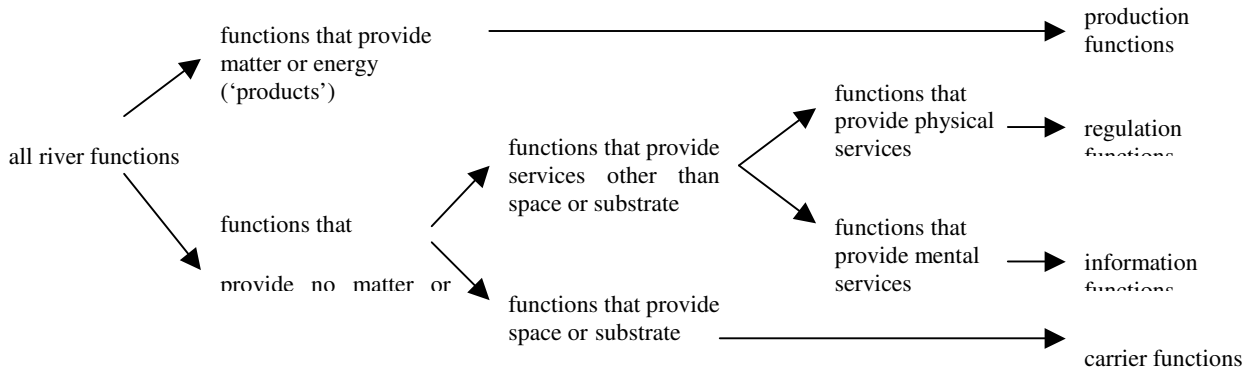

Figure 3. Distinction between different categories of the river ecosystemn (Source: Marchand, 2002)

Following from the above the main interest in this research can be summarised as obtaining insight in when who uses what for which purpose. The framework presented in this section tries to reveal all aspects which require attention in assessing the relationship between what people use and their well-being and the river flow regime required to sustain this. The next section will describe the results of applying this framework in a pilot case study in the Teesta River in Bangladesh.

3 RESULTS OF APPLICATION OF FRAMEWORK IN THE TEESTA RIVER BASIN IN BANGLADESH

The results described in this section are based on a baseline study of three selected sites in Bangladesh and on a pilot case study in Kaunia, along the Teesta river. Based on these results a more elaborate case study is being prepared to be carried out in Surma-Kushiyara basin in Bangladesh in the period of October till December/January 2003.

3.1 Teesta River

The Teesta river, which is a tributary of the Brahmaputra, is located in the north-west of Bangladesh (Fig. 3). The catchment has a total size of 12540 km^2, the largest part of which (10200 km^2) lies in India. Precipitation is less than in the rest of Bangladesh, around 3000 mm/year. Almost 80% of the rain falls between May till November, February is the driest month.

Two weirs are constructed in the Teesta, one in West-Bengal in India, the other one near Dalia in Bangladesh. The purpose of both weirs is to supply water for irrigation.

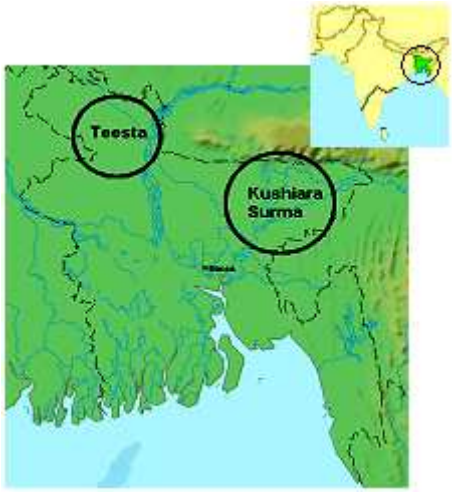

Figure 4. Location of Teesta River and Surma-Kushiyara Rivers in Bangladesh

The fact that the Teesta is the main fresh water supply in this drought-prone area in combination with the construction of dams both in India and in Bangladesh are the main reasons for selecting the basin as case study.

3.2 Functions and stakeholders

To be able to identify possible stakeholders an inventory is made of potential river functions. The identified functions and stakeholders of the Teesta river are shown in Table 1.

Table 1. River functions and problems of the Teesta

Function category	*Instream function*	*Remarks*
Carrier functions	Navigation	Teesta is not a navigable route under BIWTA classification, this means the river is used for country boats only. Navigation constricted by low flows.
	River banks, small islands (chars) and floodplains provide space for housing, farming and other activities	Erosion of land and sedimentation occur in parts of the Teesta
Production functions	Instream fisheries	Fishery is said to decline 'day-by-day'. Reason net yet clear, maybe due to barrage (reduced flows/migration barrier)
	Floodplain fisheries	Floodplain fishery is a seasonal activity
	Gravel mining	
Regulation function	-	-
Information function	Nature conservation issues	Reduced flows affect riverine ecology in drought prone area.

Source: Baseline Report Enfraim

To identify stakeholders from this function list 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, communication with other areas for local communities, or the ability for other people to transport their merchandise to other areas. Table 2 lists the different purposes the functions of Table 1 may have together with the potential stakeholders.

Table 2. Possible purposes of functions and potential stakeholders

Function	*Relation to well-being*	*Stakeholder*
Navigation	Income	Boat owner/transporter
	Communication with other areas	Local population
	Condition for trade in other areas	Various producers
Land	Possibility for housing and other activities	Local population / house and land owners
Fisheries	Income	Fishermen
	Food	Local population
Gravel mining	Income	Miners
Nature conservation	Esthetic value	Local and beyond
	Income from tourism	Tourist guides/hotel and shopowners

3.3 Well-being

A poverty assessment in Bangladesh, carried out by a NGO Working Group on the World Bank (un Nabi *et al.*, 1999) lists features of well-being from 10 examined sites:

Employment, landholding, savings
- Invest-worthy capital
- Cattle and draught power
- Education
- Healthy, anxiety free life
- Extended family

As features of a healthy and anxiety free life were mentioned the ability to wear good clothes, to take food to the satisfaction and to send children to school. Moreover, to maintain a good quality of life a household or an individual should own a good house.

At specific locations some extra features were mentioned:

- three square meals per day
- fishing nets and boats
- access to information (in areas were people lived on islands isolated from the main land)
- position in the local power structure (sometimes related to poverty status)
- ensuring low child mortality
- protection from flood erosion
- no disabled person in family

Moreover, in a problem analysis, job scarcity and natural calamity were mentioned. The problems list prioritised supply of drinking water, hygienic latrine, health care facilities and children's education. Those were followed by road and communication, population growth, dowry, insecurity, electric supply and decline of productivity of agricultural land (un Nabi *et al.*, 1999, p 9).

Such a general analysis of well-being of the Bangladeshi poor people provides insight in aspects that are possibly important to the stakeholders in our research. Some of these features may be linked to the river ecosystem. Table 3 gives some examples of river products and services contributing to some of the features of well-being mentioned above.

Moreover, the notion that some aspects of well-being are dependent on the river ecosystem while others are not, could be used to assess the relative importance of the river flow regime for people's livelihood.

Table 3. Possible relationships between well-being features and river products and functions

Feature of well-being	*Possible relationship with river products and services*
Employment	• Fisheries • Recession agriculture • Navigation • Tourism • ….and many more
Take food to satisfaction (e.g. three square meals a day)	• Fisheries • Recession agriculture • Collection of wild fruits and vegetation
Housing	• Collection of bamboo/reed as construction materials • Collection of mud and other materials to make bricks
Access to information	• Navigation

3.4 Linking well-being and the river ecosystem: pilot case study

A pilot case study is conducted near Kaunia along the Teesta River in May 2002. A combination of methods (observation, group discussion, workshops) is applied to assess what products and services the people along the river use and in what way these functions contribute to their well-being. The results are shown in Table 4.

Table 4. Products and services used to enhance well-being by stakeholders along the Teesta River in Bangladesh

Product / service	*Water source*			*Purpose for well-being*	*Stakeholder*
	River	Tubewell[1]	Pond[2]		
Washing / bathing	x		x	Health	Local communities
Recession agriculture (paddy, jute, wheat, vegetables)	x	X		Income / subsistence	Farmers / local communities
Water hyacint	x			Cheap fertiliser	Farmers
Fish	x		x	Income / subsistence	Fishermen / local communities
Domestic water use		x			
Bamboo and other materials	x			Construction materials for own housing and sale	Local communities
Navigation				Transport of materials	Local communities
Livestock:					
- ducks			x	Income / food	Local communities
- cattle	x			Income /food	Pastoralists
Providing land and space				Housing / farming	House, farm owners

1. tube wells pump water from deep groundwater, this water source is assumed to have no relationship with the river flow

2. ponds are recharged through several processes: pumping shallow groundwater, rainfall, flooding

The investigation among the stakeholders reveals that the ecosystem provides many products and services, which were not identified beforehand. What has not been assessed is how many people depend on the different products and services for the different aspects of their livelihood, also it will be necessary to quantify uses of and needs for certain products and services.

Moreover, it is difficult to assess the importance of river flows. Flooding due to too high flows brings problems as well as positive effects. Accessibility of groundwater in this area provides an alternative water source during low flows. However, in many areas in Bangladesh groundwater contains arsenic, and people who have been drinking this water for a long time suffer from arsenic pollution. In the case study people have been asked to what purpose they use a certain product or service from a certain source, however, what purposes are perceived to be more important, the preferences and alternatives they have has not been addressed explicitly.

The general perception of the people turn out to be two fold: the river ecosystem provides indeed products and services to them, however, the river is considered useful only when it does not flood their village and enters their houses. Only one woman mentioned that flooding is useful because it deposits fertile silt on the farmlands. These two side of the same flow show that in assessing requirements to river flows it is necessary to consider both minimum and maximum constraints and preferences, and that it is necessary to assess who are positively and who are negatively affected by a certain flow regime.

This section showed that research among stakeholders reveals more functions of the river ecosystem then originally thought (Compare Table 1 and 4). However, the first inventory on

which table 1 is based is useful as a starting point for further analysis of functions and stakeholders.

4 CONCLUSION AND DISCUSSION

This paper has described an analytical framework for revealing the relationships between stakeholders and the river flow regime. Insight in these relationships is necessary to adequately take the interests of stakeholders into account when assessing environmental flow requirements.

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 pilot-case study along the Teesta 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 people's well-being.

The next steps will be: (1) a further testing of the framework in a more elaborate case study in the Surma-Kushiyara river basin in Bangladesh in the period October – December 2003. Based on which the framework will be adjusted and further developed. Moreover, a case study in another country is planned for 2004; (2) the extension of the framework for incorporating the found relationships in river basin management. Based on these steps recommendation for improvement of existing EFAs will be done.

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