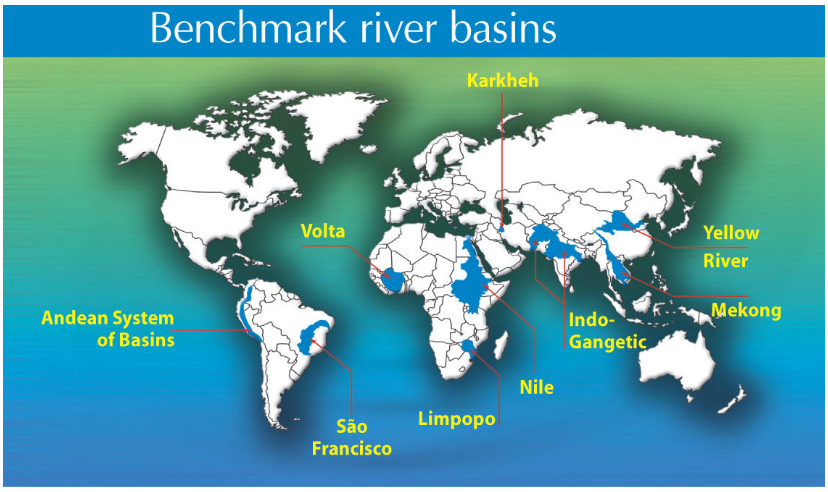
MAPPING WATER POVERTY:
Water, Agriculture and Poverty Linkages

Basin Focal Project
Working Paper no. 3

WORKING WITH PARTNERS TO ENHANCE AGRICULTURAL WATER PRODUCTIVITY SUSTAINABLY IN BENCHMARK RIVER BASIN



DISCLAIMER

This is an advance edition of *Mapping water poverty: Water, agriculture and poverty linkages*, and is a **draft version** of a working paper to be published formally by the Challenge Program on Water and Food. This report contains less than fully polished material. Some of the works may not be properly referenced. The purpose is to disseminate the findings quickly so as to invigorate debate.

The findings, interpretations, and conclusions expressed here are those of the author(s) and do not necessarily reflect the views of the Challenge Program.

Comments and additional inputs that could contribute to improving the quality of this work are highly welcomed.

They should be sent to the authors:

Simon Cook – s.cook@cgiar.org

and/or

Francis Gichuki - f.gichuki@cgiar.org

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1 INTRODUCTION

The Challenge Program on Water and Food (CPWF) aims to support the three development goals of poverty alleviation, improved health and environmental security through improved water productivity. A lack of water productivity constrains well-being, and while there are hundreds of case studies illustrating how this occurs, we have yet to see a consistent basis on which to evaluate the modifiable relationship between water, agriculture and well-being within basins, at scales which can support intervention.

In short, the program requires a coherent analysis of ‘water poverty’ that provides a reasonable statement of the degree of water-related constraints to human development. Since we focus on agriculture, this translates into a measure of the shortfall between the potential and actual livelihood support provided by water in agriculture.

The paper discusses the role of water in agricultural productive systems and the way it links to poverty. Poverty is defined as the lack of well being attributable to water. Detailed analysis of water-related poverty proves to be extremely useful to the CPWF and other stakeholders. The role of water in rural lively hood, and constrain that it imposes on human well-being due to availability and the accessibility of water are captures in this paper. Since the human well-being is govern by the interaction between resources and the agricultural systems which enable people to derive their livelihoods. Using the analytical models the conversion of water resource to livelihood outcome in an agricultural system is analysed in this paper. The basic logic is representable as:

$$Water\_poverty = function(agriculture, water)$$

Assumes that water is a significant factor, this new approach enables a basin-wide analysis of poverty and water, while accommodating more detailed examination of specific livelihood systems. The paper discussed the two-model approach: using dynamic hydrologic modelling to determine the status of water availability and land use / livelihood system modelling to determine the relationship of water with poverty.

The paper looks at poverty mapping, the problem associated with the poor with sufficient details at different levels to instigate targeted action. With the poverty maps so developed it will try to understand the logic behind the problem.

2 WHY ANALYZE WATER POVERTY AT BASIN SCALE?

2.1 *NEED TO MAP POVERTY AS A BASIS FOR ANALYSIS*

Davis (2003) cites two reasons for mapping poverty. Firstly, to identify the problem- where are the poor – at a level of detail sufficient to instigate targeted action. Second to provide data against which the causes of poverty can be analysed. An additional benefit– often understated- is that the rigour necessary to produce such maps expresses, often for the first time, tacit logic that underlies specialists understanding of the problem.

The objective of poverty analysis within the BFPs is to:

a) provide basin-wide spatial information about the distribution of water-related poverty;

b) support analysis of specific causes; and

c) provide transparent analysis of opportunities and risks of intervention.

2.2 THE CHALLENGE OF ANALYZING WATER POVERTY WITHIN BASINS: MEKONG EXAMPLE

By 2025, the Mekong River basin is expected to be home to a population of over 100 million people (Kristensen, 2001). All of these people will depend, to some extent, on the water flowing through the Mekong river basin for well-being, either directly as water consumers, by using it for agriculture, fishing, and forestry, or indirectly, through transport or hydro-power. Water within the Mekong supports many aspects of well being of its inhabitants. However, even within the Mekong – not generally considered as a water stressed basin (Falkenmark, 1992), livelihoods of significant numbers of people are constrained by water-related factors. These factors include:

- Insufficient access to water.
- Low water productivity
- Vulnerability to extremes of drought or flood, or health hazards associated with water
- Loss of ecosystem services.

Multiple individual case studies illustrate how these factors influence well-being. They provide powerful insight of specific individual problems. However, on their own, case studies provide little insight of the relative significance of these problems, nor of the essential basin functions that, together, influence large numbers of people within the basin.

Analysis is required to combine analysis of social condition in the region with information of basin hydrology to identify specific water-related problems over large areas and opportunities for alleviation through improved agricultural water management. Analysis must be comprehensive, i.e. examine all signficant areas, yet of sufficient resolution to identify specific interventions.

3 PRINCIPLES OF MODELLING WATER, AGRICULTURE AND POVERTY WITHIN BASINS

3.1 COMPOSITE INDICATORS OF WATER POVERTY

A number of authors seek to combine both poverty and its determinants in a single index. These offer the advantage of robust methods that can be applied generally for points or regions.

- **Water poverty index**

The Water Poverty Index (Sullivan *et al*., 2003), subsequently modified to the Water wealth Index attempts definition of poverty that includes all factors relevant to the livelihood support provided to the poor by water resources. It describes 5 dimensions: access to water; water quantity, quality and reliability; water uses; water management and environment. Maps have been produced at national scale, but the feasibility of more detailed assessment, and the interpretability of non-selective indices seems low. This concept has undoubtedly broadened the scope of examination, but the rigid definition of relative weights reduces its value as an analytical tool. WPI/WWI may provide greater value as a diagnostic indicator for subsequent analysis.

- **Falkenmark Water Stress Index**

Falkenmark's Water Stress indicator provides easily quantifiable measures that assume no direct association between poverty and water. This was modified by Ohlsson (1989) to include measures of social capital that seem likely to modify the ability to cope with stress.

Useful as a broadscale indicator of the imperative for action, this makes no distinction between impact and condition.

- ***NRM Access- based measure***

Rijsberman (2005) proposes an index based on a combination of poverty, access to NRM and dependence on NRM. Details are appended. This approach could be trialled in basins to determine availability of data and interpretability. Its strength appears to be in linking poverty to resource endowments. Likely problems include the danger of hidden assumptions of the direct linkage between resource indicators and well-being (see section above).

3.2 DEFINING AN ANALYTICAL MODEL THAT RELATES WATER, AGRICULTURE AND POVERTY

Water is used in a variety of both productive and consumptive activities and contributes to rural and urban livelihoods in many different ways. Lack of access to drinking water is itself an indicator of poverty, but, the role of water in human well-being is far more complex than simply access to drinking water. Food crop production, fishing, agro-processing, and health can all influence and are influenced by the quantity and quality of available water. Rural upper catchments largely contribute to downstream livelihoods by providing valued primarily ecosystem services to downstream urban, agricultural, and industrial users. As the principal water user, agriculture offers significant, if complex, opportunities for improvement of livelihoods for both consumers and 'producers' of water.

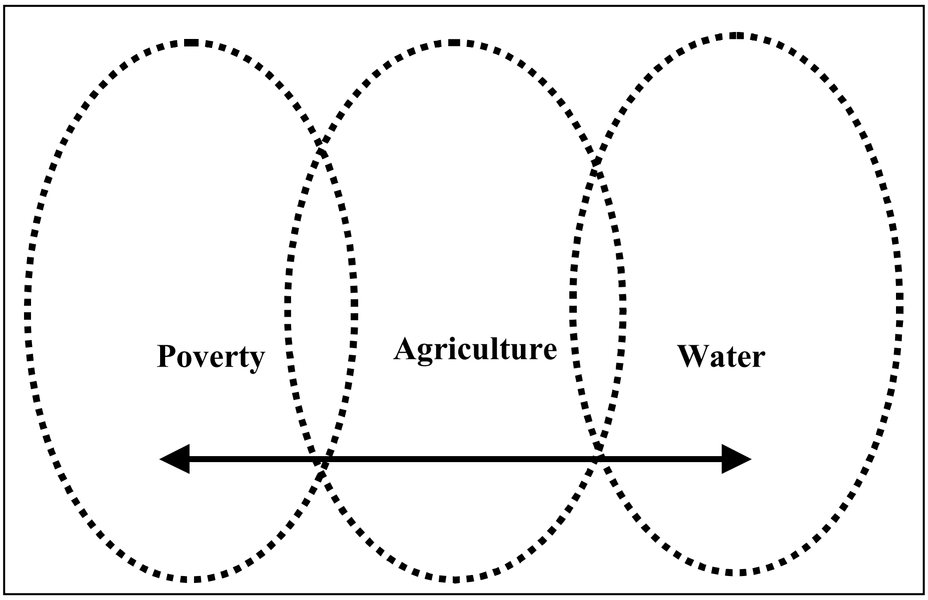

Figure 1: Water use, agriculture and poverty linkages

A full understanding of the role of water in rural livelihoods will include aspects of use, distribution and access (see Comprehensive Assessment). The constraint that water places on well-being is attributable to two factors: its availability and the way in which people use it. People will derive well -being through the interaction between the resource and agricultural system so we have a three-variable system in which *poverty* (which we define for now as the lack of well-being attributable to water), is a function of the *resource availability* and the *agricultural* system that enables people to derive livelihood from it.

3.3 REPRESENTING THE AGRICULTURAL LIVELIHOOD SUPPORT SYSTEM

The third factor to be modelled is the conversion of water resource to livelihood outcome in an agricultural system. This can be considered as a simple triangular relationship in which water is available to individuals (WA) and converted into livelihood support through the concept of water productivity (WP)

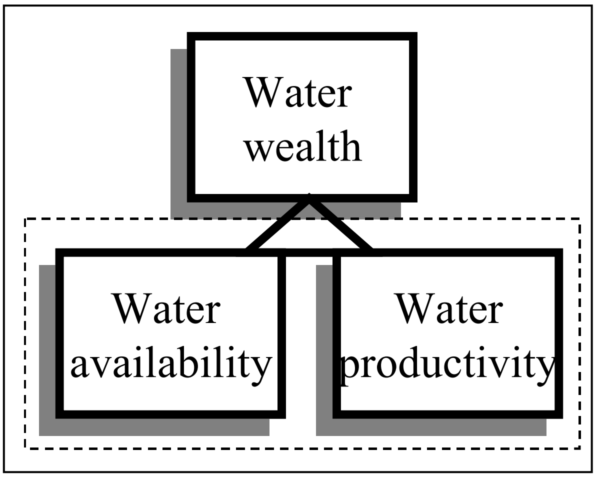

Figure 2: Water availability, productivity and wealth linkages

- **Water productivity as an indicator:**

Maps of water productivity are expected to be intrinsically valuable as indicators of condition or potential water availability. It may be useful to remember, however that, as presented here, WP essentially describes the conversion factor of water resources to livelihood. On its own, an assessment of WP provides an incomplete picture of Water Poverty and requires additional information before it can describe major causes of variation in livelihood.

Assessment of WP alone might be useful, for example to highlight 'hotspots' of high water productivity in the delta, and broad areas of poverty, such as in Cambodia and Upland Laos.

- **Direct statistical associaton of poverty and water variables**

It may be possible to determine statistical associations between water availability and poverty without accounting for productivity of the agricultural system. Such models assume causal factors, mostly mentioned above, such as use, access or hazard. As shown by Farrow et al, (2005; see figure below) such factors may be necessary to explain the linkage between water and poverty – in this case drought stress correlates both positively and negatively within different regions of Ecuador on account of the different response of the agricultural system. Accordingly, , we must model the resource (water) within the agricultural system that converts it into livelihood. The basic logic is representable as:

$$Water\_poverty = function(agriculture, water)$$

Basically, there seem two inferentional pathways for the analysis of water-modifiable poverty:

Identify the incidence of poverty and *infer,* from analysis of ancillary information, how much is modifiable through better water management. This is called backward chaining: *from* analysis of ***Y***, *infer* the influence of ***X***. Model development will most likely start from this perspective.

Identify the biophysical condition of the system and *infer,* from modelling, the impact of change on the poor. This is forward chaining: From ***X***, *infer* the likely status of ***Y***. This describes testing of a model that can be used to predict conditions for which direct observation is not possible.

Mapping water poverty - that is the poverty induced by inadequate or harmful water - therefore needs to decide what is tractable. There are two options to consider:

- On the left-hand side of the expression we could try and map poverty, which we could define as the lack of beneficial outcome of water use. The aim would be to either identify the incidence of poverty that is attributable to water (see below about mapping poverty). This option has the advantage of being sensitive to the results of a virtually infinite range of human adaptability to an uncertain resource condition. However, such measures are also likely to suffer from ambiguity since it will prove difficult to disentangle cause of variation of the outcome. The option to map the left hand side of the expression are limited by data availability. Considering the Mekong, for example, poverty surveys exist for some parts of the basin, but with the notable exception of Vietnam (Minot and Baulch, 2005) this data is normally unavailable at a resolution to determine causal relationships with hydrologic features. Spatial analysis can improve this resolution to a level that allows comparison with biophysical variables (see Hyman *et al.*, 2005). Some details are discussed below.
- Alternatively, we could try the forward chaining approach, and pursue information about the right-hand side of the expression: principally the positive and negative water resource endowments and the system that enables livelihood outcomes. This follows more traditional approaches such as hydrologic, land condition and vulnerability mapping but in a more transparent modelling process specifically directed at water. Analysis of land condition has the advantage of clarity: water is either saline or not. However, it reflects no adaptability so in all but extreme cases seems unlikely to correlate closely with poverty without further modelling.

The above problems have been dealt with, to an extent, with mapping of 'static' natural resources such as suitability or stress (see FAO Terrastats). The situation is more complex when mapping a dynamic water resource. First, water moves so that activity at one place may influence well-being at another, sometimes over very large distances. Second, water balances can be disturbed profoundly by human intervention, deliberately or unwittingly. Third, within an agricultural system water passes through several phases and is highly uncertain in each, being subject to large spatial and temporal variations.

3.4 DECIDING WHAT FEATURES OF POVERTY TO MAP

The results of the poverty mapping project (Hyman *et al.*, 2005) emphasise the need for improved water management - most country case studies determined at least one water-related cause of poverty (see table). However, this study also highlights the difficulty of selecting a single measure of water poverty. In most cases, water-related causes of poverty are non-unique, and non-exclusive. A range of factors can cause problems. Some of them act in ways which are virtually unpredictable, through intermediaries such as effects on agricultural employment, access to markets; lack of confidence.

Similar difficulties faced the definition of poverty itself in the 1980's (Ravaillon, 1992), who concluded that the principle benefit from poverty assessment was not to provide absolute measures but to enable **comparison**. In pursuit of a single consistent measure, assessment had to overcome three conceptual difficulties:

i) Identify what is meant by 'well-being' from a range of conceptual perspectives

ii) Determine a sensible cut-off at which someone is deemed to be poor or non-poor

iii) Aggregate several indicators into a single measurement.

Over 20 years later, methodological development continues (Coucouel, 2002), though with a well-established suite of analytical techniques that are of accepted value to achieve four objectives.

The measurement and analysis of poverty, inequality, and vulnerability are crucial for **cognitive** purposes (to know what the situation is), for **analytical** purposes (to understand the factors determining this situation), for **policymaking** purposes (to design interventions best adapted to the issues), and for **monitoring and evaluation** purposes (to assess the effectiveness of current policies and to determine whether the situation is changing).

Table 1: Explanatory variables from country case studies of poverty mapping

Mexico •Indigenous groups •Education •Accessibility •Population density Ecuador •Accessibility •Water availability •El Niño •Land tenure Nigeria •Rainfall •Vegetation (more analysis needed)	Malawi •Educational attainment •Non-agricultural activities •Dependency ratio Kenya •Soil resources •Rainfall and climate •NDVI (vegetation vigour) •Access to education •Accessibility to towns	Bangladesh •Educational attainment •Availability of infrastructure •Land tenure •Flood-prone lands •Soil suitability for rice cultivation Sri Lanka •Access to land and water

Source: Hyman and Imminck, 2003

3.5 ASSESSING RESOURCE CONDITION

The resource may be assessed in terms of land condition, or more dynamic hydrologic modelling.

- **Land condition assessment**

Quantifying the land condition should prove easy. Most basins will have broadscale maps of land condition, that could be translated into more meaningful variables. Land condition, and land condition change can be measured reliably at high resolution, over continental areas, using remote sensing techniques (dsee http://www.cmis.csiro.au/rsm/index.htm). Maps of land use change, coupled with more detailed studies of dynamic processes would highlight areas may identify risks to water balance, particularly in the upland forests of Laos and Vietnam. Definition of areas of salinity risk in Northern Thailand would identify problems to agricultural development, as would maps of seasonal drought risk to cropping in Laos. Inventories of fisheries and environmental flows could help indicate vulnerable systems.

- **Mapping Dynamic Processes:**

Indicators provide a static ‘snapshot’ of conditions that, in reality, change constantly in response to external pressures of population, trade, conflict or climate change. Yield, biomass and flow will reflect actual antecedent conditions, rather than average, or expected conditions.

Good indicators should provide stable diagnostics that comment on a situation over a defined time period. However, changes in one part of a basin will, we hope, improve or conserve conditions elsewhere so the diagnostics may need to be linked to dynamic modelling processes to assist decision making.

Experience shows that this process quickly becomes very complex, according to the number of factors to be considered, the geographical range and the uncertainty of each. Land use modelling has tackled some of these problems with varying elegance, leading to full complexity agent-based modelling in which the methods are generalizable but the results unique for a given case study.

3.6 DESCRIBING HOW VARIATION OF WATER RESOURCES LINKS TO LOCAL LIVELIHOOD SUPPORT

Assessment of resource condition and of the system in which it is used both contribute partial understanding to water-related poverty. But independently they fail to connect between basin hydrology and local land use. Assuming that water is a significant factor, a new approach is required that enables basin-wide analysis of poverty and water, while accommodating more detailed examination of specific livelihood systems. What follows is a re-statement of the overall problem and a discussion of the approaches to satisfy the demand for coherent methodologies.

Research must identify the access poor communities currently have to water, and how is that likely to change over time with changes in the face of demand for water, and factors such as price for water or agricultural product.

The ability of water assets to contribute to rural livelihoods is vulnerable to both natural and social pressure. As a collective resource, people are obliged to share water over which they may have little or no right. Uncertainty and insecurity affect the contribution to rural livelihoods, with implications regarding exploitation and/or conservation.

The ability to identify the pressure points quantitatively —where water assets are critical and vulnerable— is crucial and not always easy because many of the important drivers are difficult to observe. The full significance of water as a determinant of poverty may be undetected because the water-related factor may be highly uncertain – even relatively straightforward features such as drought may be difficult to define in analysable form (Smaktin, 2003).

Poverty is linked to resource degradation. The relationship between poverty and natural resource degradation has been described as a downward spiral, where poverty drives over-exploitation, which in turn deepens poverty (World Commission on Environment and Development, 1987). Factors that condition how poor communities manage their resources include available technologies, markets and prices for labour and commodities, property rights, resources characteristics and socio-cultural and demographic factors.

Research needs to understand how these factors combine to create incentives for sustainable land and water use, and develop technologies and policy support to increase the chances of better land management by the poor. Ensuring this outcome will require an appreciation for the diversity of livelihoods of up and downstream users, as well as of the ecological conditions.

The problem is that, as shown by the poverty–mapping case studies (see Hyman *et al.,* 2005), when examined in detail it becomes apparent that there is no universal relationship to be determined between poverty and environmental condition. Factors vary between and within basins and at the scale at which they are examined. Not all poverty is water-related. Not all water-stressed people are poor. The variation in response to resource availability is almost infinite.

A major problem of mapping the effects of water on poverty is that insight is required at three scales: household, community / sub-national and basin scale. Poverty is perceived at household scale, interventions tend to occur at community or sub-national scale, and the overall effects are subject to control at basin scale. Oddly enough, an analogous problem is perplexing medical researchers, and some advanced research programs have been established to build modelling frameworks that can handle cascades of models from the cell, through organ, to whole-body (Crampin *et al.* 2003; Tawhai and Ben-Tal, 2004). This approach seems more appealing than the multi-scale approach used by ecologists or climatologists because it recognises the 'sense' of systems at successive scales.

3.7 DATA-DRIVEN OR KNOWLEDGE-DRIVEN MODELS:

Basin scale analysis is likely to lack sufficient data for comprehensive analytical modelling, especially if livelihood support processes need to be examined in detail. Data-driven models may be feasible in some areas, but for many, this will not prove possible. How can knowledge -generally a more available resource- be represented spatially on the basis of patchy, and often qualitative data?

The concept of spatial representation of qualitative attributes is considered to be a reasonably mature in spatial sciences (see Hernandez, 1994). One application for sub-basin management is described by Reynolds *et al*.; (2000).

4 MODELLING WATER-RELATED POVERTY

We suggest the following components for a basin-wide water poverty modelling process:

- Conceptual model. Determine what features need to be included to represent the variation of water-related poverty, how to handle multiple scales and what form of inference to use.
- Poverty mapping: Seek the best available information to describe poverty that can be analysed with respect to water resource condition.
- Describe the water-based livelihood system in a way that can be represented by data of hydrology (or land condition) and factor that represent the agricultural system (e.g. WP).
- Hydrological and land condition mapping to derive information on explanatory variables. This is a major requirement that will draw on well-developed expertise.
- Analysis and scenario modelling. Possibly the major activitiy that tests the models for consistency and provides predictive representations of the extent of opportunities and risks.
- Development of summarised composite water poverty indices. This should be completed last, to ensure that the index is based on best available analysis.

4.1 THE CONCEPTUAL MODEL

The complete model relating water through agriculture to poverty (Figure below[1]) is provided by Meinzen Dick *et al* (2005, Comprehensive Assessment). Clearly, this must be reduced to more tractable proportions. A two-model approach seems sensible: using dynamic hydrologic modelling to determine the status of water availability and land use / livelihood system modelling to determine the relationship of water with poverty.

- **Models for mixed land use systems:**

A complication may arise where contrasting land use systems co-exist in the same space, such as capital-intensive irrigation interspersed with rainfed small-holder agriculture. This seems significant in parts of the Sao Francisco and Limpopo.

- **Inference mechanisms:**

[1] Note that the sense is reversed, i.e. poverty is on the right, and water resource on the left.

As noted above, there seem two pathways for the analysis of water-modifiable poverty:

Identify the incidence of poverty and *infer,* from analysis of ancillary information, how much is modifiable through better water management.

Identify the biophysical condition of the system and *infer,* from modelling, the impact of change on the poor.

The first pathway will be used to determine the model. It seems likely that statistical analytical tools will be used to determine relationships between poverty (Y) and water resource condition (X). Examples of analytical methods to determine the relationship between poverty and environmental variables can be found in Hyman *et al.,*(2005).

Need more examples of analysis of poverty

The second inferential pathway will be used for prediction and scenario building. This starts with estimates of water resource condition and represents the livelihood outcome in terms of threats (hazard) or opportunity (suitability). Such models can be built into GIS relatively easily using the following logical tools :

Data-driven models, based on statistical analysis. These may work over large areas for which data is well provided, but there may be insufficient data for high resolution modelling. Should sufficient data be available, these models are normally preferable.

Rule-based functional models. These could use a mixture of rules derived from statistical analysis and logic to represent water poverty (note this is the usual method for general indices).

Bayesian belief networks, based on a mixture of knowledge and data. These can represent the relationship between poverty and factors with which it is associated to a degree known from analysis of data, or logic.

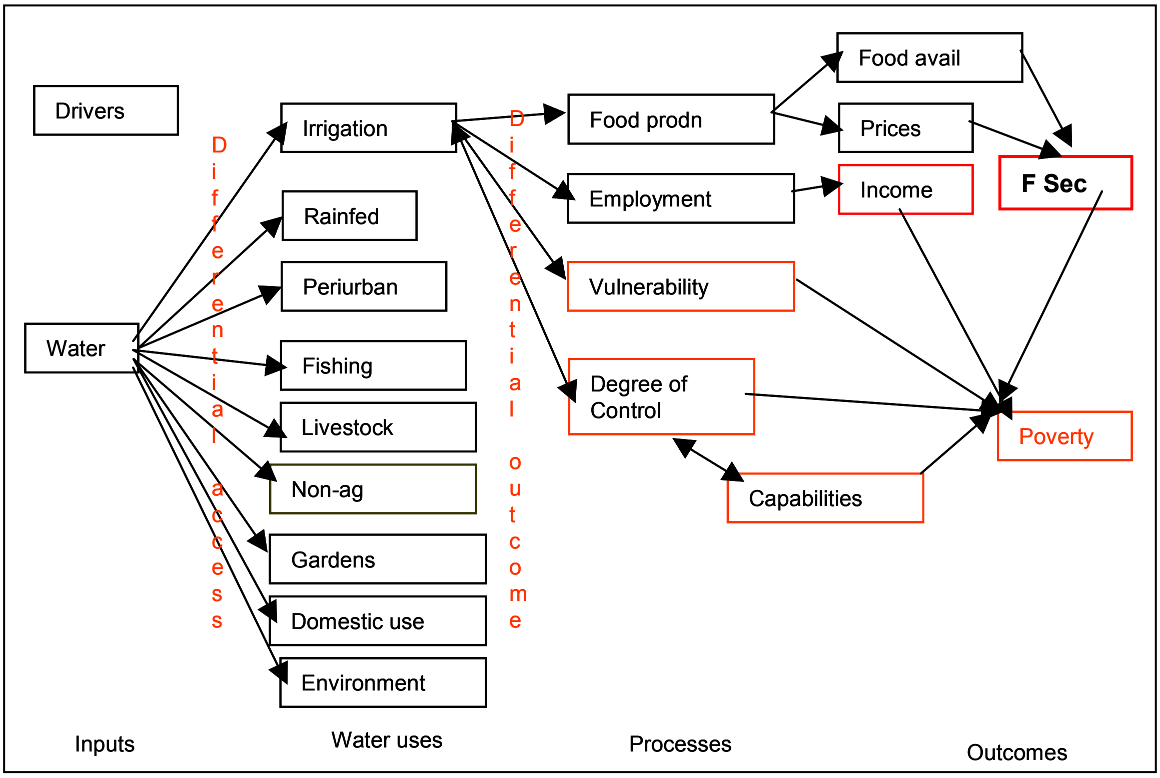

Figure 3: Water use, agriculture and poverty outcomes

4.2 MAPPING POVERTY

The first step is to maximise the spatial resolution of poverty or other livelihood information. As illustrated by all poverty mapping case studies (see Povertymap.net), resolution of spatial and temporal information determines the visibility of process. Put another way, coarse resolution spatial data of livelihoods, such as exists for Laos or Volta, provides little basis for analysis of water poverty. National-level statistics provide no information about local access to water resources. Census data may provide no data about household level processes. Farrow *et al*., (2005), show how analysis at the wrong scale may obscure highly significant local factors through a process of spatial aggregation, hence loss, of critical information.

The basic method of high resolution poverty mapping is to develop a three-variable model in which detailed variation of poverty measure is inferred indirectly from a 'dummy' variable that is available in more detail to another variable of interest with which it can be related statistically (Henninger and Snel, 2004). For example, census data that provides comprehensive coverage may be analyzed *with* household survey data to provide a comprehensive coverage with high resolution. The statistical model varies spatially using a third variable to supply independent information.

Spatial disaggregation may be possible using spatial regression or similar techniques, depending on the availability of associated high-resolution data. The resolution achievable depends on the availability of data, which will vary for each basin. Generally available biophysical data include DEM (90m., Jarvis, 2004) monthly (1 km.) and daily (18km) rainfall, land use classification. Crop yields and biomass may be accessible indirectly (see Water Productivity working paper). Socio-economic data varies widely in quality but is rarely available below census district level.

4.3 REPRESENTING THE WATER AND AGRICULTURAL SYSTEM

- **Water Productivity**

The measure of water productivity is appealing because it provides a ubiquitous measure of the ability of people to use water for agricultural production. Notwithstanding its own difficulties of interpretation where the marginal value of water is low, water productivity is a generally valuable measure of 'how well people convert water into food'. For discussion, two other possibilities are proposed here. In both cases, the essence is to identify the performance of a given water resource to support well-being.

- ***Relative Water Productivity.***

In a similar vein, another simple indicator might be to look at *relative* WP, i.e. the ability to produce from a given resource (land/water) in comparison with areas of similar resource endowment (identifiable using Homologue, (Jones et al, 2005)). This might offer a diagnostic index showing where WP is lower than might be expected, for a given environment.

Three basic conditions exist:

- 'Benchmark' sites fulfilling high WP potential. These are the sites in which people have developed the best livelihood support systems for a given suite of physical conditions.
- Sites with low potential WP, for reasons of unfavourable rainfall distribution, infertile soils, or inhospitable terrain. In these sites, WP is low and difficult to modify.

- Sites with unfulfilled potential WP. In these areas, something is constraining the ability of people to achieve a level of productivity equivalent to sites with similar biophysical endowments in other areas.
- **Functional modelling of the water and agricultural system**

Samad (2004) attempted to identify specific water-related causes of poverty from detailed poverty assessment in Sri Lanka. The assessment faltered because of the difficulty of correlating productivity to rainfall measures, which is all that was available as an indicator of access to water.

4.4 DESCRIBING LAND CONDITION:

A pragmatic alternative is to identify the incidence of physical conditions (such as hazards of drought, floods, lack of access or positive attributes such as suitability) that are related to well-being and poverty in a known way. The strengths of this approach are:

a) Vulnerability or suitability assessments provide actionable information.

b) Methodologies exist for mapping major hazards. Suitability mapping dates back to the 70s.

c) Users are familiar with the concepts.

Weaknesses of the vulnerability assessment include

d) Vulnerability assessments fail to provide a single general indicator which correlate with poverty because of differences in system resilience. A ‘flood’ in Minnesota may result in a ‘disaster’ in Mozambique.

e) Models are difficult to calibrate, since what is being mapped is generally ‘potential’ hazard or opportunity, rather than actual. Decision-makers will soon ignore such information unless it is taken to the next step of interpretation.

5 SUMMARY: UNDERSTANDING THE POTENTIAL AND PITFALLS OF WATER POVERTY ANALYSIS

Detailed analysis of water-related poverty will prove extremely useful to the CP and other stakeholders. They will not only identify where water-related poverty exists – that is, where people derive less than achievable benefit from a given water resource- but also, through inference, provide major advances in insight about potential interventions within basins.

However, other factors may reduce the analytical power of the information, making this a first big step in a journey of increasingly rigorous assessment. Correlation between indicators based on water productivity and poverty are likely to be influenced by a range of factors, not included in water productivity, that will influence their accuracy:

- Marginal value of water outflows
- Urban-rural flows of income (e.g. remittances)
- Other forms of non-, or under-accounted livelihood support (e.g. fisheries, non-timber forest products, ecosystem services)
- Future livelihood support

Attempts to include a range of factors in a single indicator are likely to be fruitless and demonstrate the law of diminishing returns. A pragmatic approach would be to take an experimental approach to determine the simplest and most robust composite water poverty indicators that can operate at basin scale, by comparison with existing analyses and expert judgment, and to proceed further with specific analysis.

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