Publications

Tittle : **Agricultural drainage - Towards an integrated approach**

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Abstract

Drainage needs to reclaim its rightful position as an indispensable element in the integrated management of land and water. An integrated approach to drainage can be developed by means of systematic mapping of the functions of natural resources systems (goods and services) and the values attributed to these functions by people. This mapping allows the exploration of the implications of particular drainage interventions. In that sense an analytical tool for understanding a drainage situation is proposed. The process dimension of the functions and values evaluation and assessment is participatory planning, modelled on co-management approaches to natural resources management. This provides a framework for discussion and negotiation of trade-offs related to the different functions and values related to drainage. In that sense the approach is a communication, planning and decision-making tool. The tool is called DRAINFRAME, which stands for Drainage Integrated Analytical Framework. The implementation of an integrated approach posits challenges for the governance, management and finance of drainage, as well as for research and design of drainage infrastructure and operation. Both have to be rethought from the perspective of multi-functionality. The paper concludes with five main policy messages.

Key words: drainage, integration, functions, values, participatory planning, governance, institutions, technology.

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Introduction

Drainage is an inherent part of the hydrological cycle – a necessary function of a river basin or other hydrological units. Drainage is a natural process that human beings adapt for their own purposes, redirecting water in space and time, and by manipulating water levels. In this process they make use of the natural properties of the topography, the soil and the hydrogeology, and of technologies and other physical and management interventions.

Improved drainage can contribute to considerable increases in crop production in different parts of the world. Investment would be cost effective and have the additional benefit of avoiding exploitation of new land and water resources. It has been estimated that 50 percent of the world's irrigated land suffers from drainage problems. Twenty-five million hectares of prime agricultural land have become unproductive due to irrigation-induced waterlogging and salinity (Smedema, 2000). Two hundred and fifty million hectares of rainfed cropland need improved drainage (Smedema et al., 2000). Improved drainage can also produce substantial benefits in the sphere of health, reduction of damage to roads and buildings, and flood control. On the face of it, improvement of drainage could be an important instrument in achieving sustainable human development.

Paradoxically, drainage has almost disappeared from international water discourse as a theme and a concern. Drainage has become a 'forgotten factor' (Scheumann and Freisem, 2001). For both conceptual and practical reasons drainage needs to be seen differently – by drainage professionals and by others involved in the policy, planning and practice of natural resources management for sustainable human development – of which drainage is an inherent and necessary element. The intensity of problematic issues related to drainage that societies need to address is only increasing, and with it the potential for livelihood enhancement, poverty reduction and sustainable resource management. The low profile of drainage is unwarranted. Drainage needs to reclaim its rightful position as an indispensable component of the management of land and water, not from a sector but from an integrated perspective. And herein lies the resolution of the paradox.

This paper summarises the results of a study conducted in 2002 and 2003 under the World Bank-Netherlands Partnership Programme – Environment Window (BNPPEW) called *Agricultural Drainage: Towards an Interdisciplinary and Integrated Approach*. The first phase was a set of six country case studies[2] covering different drainage situations: Bangladesh, Egypt, Indonesia, Mexico, the Netherlands and Pakistan. The final phase of the study used the country case studies as its base material in an attempt to answer the question: what are the contours of an integrated approach to drainage? The full report will appear as a World Bank Technical Paper.

The objectives of the study were: (1) Improve understanding of drainage systems as socio-technical and environmental systems; (2) Document and evaluate different institutional models in use in the drainage sector at both users and agency levels; (3) Contribute to improved design and implementation of interventions in the drainage sector

The Integrated Perspective: Why?

Drainage, with few exceptions, is generally considered from a narrow sector angle. A review of the global experience shows a wide range of drainage situations with different impacts and affecting many functions of the natural resource system. The sector approach gives drainage its low profile and isolation from the big picture of integrated management of land and water.

Impacts: Drainage has many impacts, of which the main categories are agricultural impacts, public health impacts, buildings and roads impacts, and ecological impacts. In planning and designing drainage interventions these impacts are not equally addressed. The following are lessons and conclusions drawn from the country case studies.

1. Drainage's impact on agricultural production and productivity can be substantial, agricultural drainage investments may have short payback periods, but drainage planning needs a relatively long planning horizon and flexibility because drainage needs may change over time.
2. Drainage's contribution to public health, drinking water supply and sanitation can be substantial but is generally not acknowledged, and depends on the quality of operation and maintenance of the drainage system.
3. Drainage's importance for the protection of buildings, power and telecommunication lines, roads and archaeological sites is underemphasised. The appreciation of land value and the introduction of 'sites-and-services' approaches might be considered in drainage evaluation and planning.

[2] The reports of the country case studies are published on the World Bank website (www.worldbank.org/irrigation-drainage)

4. Agricultural drainage has often had negative effects on ecological functions and has also acted as a conduit for the spread of wastewater and other pollutants. However, there are examples of drainage enhancing ecological functions, but substantially more emphasis needs to be put on mitigating drainage's negative effects and balancing its impact on production functions with that on other functions.

Diversity: Drainage situations exhibit diversity in term of the combinations of natural resources systems functions affected, scale, historical evolution, environmental factors (climate, elevation, soil, groundwater quality, biology and ecology, vegetation cover), and social factors (prosperity and values, distribution of power and cultural background, socio-political structure). Listing of diversity in drainage situations encountered across the world and the variety of factors causing it shows that 'drainage' is a container concept, covering an extremely varied set of instances. Talking about drainage in general is therefore hardly useful – neither at an analytical level nor at an intervention level. A context-specific approach is required for both analysis and intervention.

Drivers for change: The drivers for a change towards an integrated approach to drainage are the following.

1) The increasing complexity of water control systems,
2) The conflicts of interest in many water management systems,
3) Re-prioritisation of land and water management objectives because of changing societal values, and
4) The declining lustre of drainage as a professional sector and the need for the professional drainage community to rethink its position.

Based on this analysis of the present situation with regard to drainage a new, broader definition of drainage, less exclusively focussed on agricultural productivity, can be formulated as a first step towards an integrated approach.

"Drainage is land and water management through the processes of removing excess surface water and managing shallow water tables – by retaining and removing water – with the aim of achieving an optimal mix of economic and social benefits while safeguarding key ecological functions."

More specifically, integrated management of drainage would mean the following.

1. Acknowledgement of the multiple objectives served by the management of shallow water tables and the disposal of excess surface water, and of the need to reproduce the resource system over time (resource sustainability).
2. Adaptation of drainage interventions to the natural resources system, taking into account the diversity of drainage situations and aiming at optimization of goods and services produced by the natural resources system (planning and managing diversity and multi-functionality)
3. Inclusive forms of (drainage) governance and decision-making with representation of the different stakeholders (democratization).
4. Improvement of the scientific knowledge base through a major shift in the focus of the scientific community towards the fields of sustainability, multi-functionality, and stakeholder representation in governance and decision-making.

DRAINFRAME: Functions and Values Analysis and Assessment

To operationalise an integrated approach to drainage a tool called *Drainage Integrated Analytical Framework* (DRAINFRAME) is proposed for planning and decision making purposes. The first element of this tool is a functions and values analysis and assessment of (interventions in) a natural resources system. This is discussed in the present section. The analysis and assessment procedure is embedded in a participatory planning process, which is discussed in the next section.

Functions and Values Analysis and Assessment

'Functions' is a concept that summarises the goods and services that natural resource systems provide and perform. These functions include production functions, processing and regulation functions, carrying functions, and significance functions. *'Values'* is the concept through which societal preferences, perceptions and interests with regard to resources are summarised. These values are social, economic and (temporal and spatial) environmental values. 'Functions' and 'values' are expressions of complex biophysical and societal processes, which are the object of study of a large number of scientific disciplines, and which are spoken for by an array of interest groups/stakeholders.

The analytical framework for doing a functions and values analysis and assessment is presented in Figure 1. The starting point in this analysis is that people realise the values and utilise the products (goods) and services that are provided by landscapes. In economic terms, society constitutes the *demand side*, and the resources constitute the *supply side*. Simply stated, sustainability deals with the equilibrium in supply and demand, now and in the future. Perceived imbalances in this equilibrium trigger institutions to act by managing either the supply from nature or the demand from society, or both. The figure depicts how the need for institutional arrangements, technology and infrastructure, and knowledge and human resources capacity is triggered by a perceived disequilibrium in the relation between supply and demand. The demand for goods and services from nature may surpass the available supply, which leads to a present or expected future problem (e.g. over-exploitation or insufficient supply), or the potential supply may be larger than what is actually being used, representing a development opportunity. The analysis proceeds by a series of analytical steps that look at both the physical and social change processes induced by a particular drainage intervention (see Figure 2; for details see the final report of the study). It requires discussion and negotiation between stakeholders of trade-offs and identification of feasible alternatives or mitigation measures for residual impacts of the selected intervention. The steps are not necessarily sequential; iteration is an important characteristic of the approach.

The Appropriate Level for Analysis and Planning

Drainage situations can be distinguished at different levels of aggregation or geographical scale. Four levels of analysis can be defined (see Table 1)

'Landscapes' are the logical level for integrated planning of drainage interventions. This level of aggregation provides a coherent set of functions that deliver goods and services for society (agricultural production, water supply and sanitation, tourism, navigation, fisheries, etc.). Groups in society value these good and services and become stakeholders. Drainage interventions aim to enhance certain functions for the benefit of these stakeholders. Institutional arrangements are created to manage these interventions. Thus landscapes provide the consistent set of functions that forms the basis of concrete planning. It provides the proper level of analysis for understanding the dynamics of a drainage situation and to assess the potential environmental and social consequences of an intervention. Within landscapes the (in-)compatibility of function development is the main planning and management challenge. Since functions of a landscape tend to be interconnected, the whole unit needs to be considered when preparing strategies for interventions (strategies are coherent packages of measures). Landscape-level characterizations serve the planning of such drainage strategies.[3]

[3] The landscape concept as elaborated in our approach closely resembles the ecosystem approach as adopted in the Convention of Biological Diversity.

Table 1: Four scale-levels for analysis and planning of drainage

Resource system	*Composition/unit*	*Dominant Functions*	*Management focus*
Large river basin	Several hydro-ecological regions.[4]	Water functions	Allocation issues; quantity and quality monitoring; database management; sharing costs and benefits
Hydro-ecological region	Family of landscapes belonging together, but with different characteristics	A few functions giving rise to particular issues	Policy making on these issues
Landscape	'Homogeneous' resource base	Typical set of functions	Planning of optimal mix of benefits
Drainage system	Parts of landscapes	Few target functions	Interventions; daily operation and maintenance

Participatory Planning:

The Process Dimension of DRAINFRAME

The description above of the functions and values analysis and assessment methodology makes reference to the need to involve the different stakeholders as these are the carriers of the different values, and to the iterative character of the process. The latter implies that the process requires interaction, communication and negotiation of the different stakeholders regarding the interventions that are planned. The notion of participatory planning thus is implicit in the methodology.

The term 'participatory planning' is chosen to refer to a series of approaches that emphasize stake-

[4] Given the enormous diversity of water resources situations there are bound to be exceptions to this neat 'river basin consists of several hydro-ecological regions' formula. Several small or very small river basins may form a single hydro-ecological region (examples would be parts of the Kerala coast in India and the island of Bali). In very flat areas where several rivers form and occupy a delta or plain, and where the basin concept loses some of its applicability, a hydro-ecological region may cover parts of several large river basins (examples would be Bangladesh and the Indo-Gangetic plain). As emphasised below, the determination of useful units is part of the participatory planning process.

holder involvement in decision-making for natural resources development and management. Without advocating any particular approach, the focus is on the central features of processes of participatory planning. The precise features of a particular process are context specific and need to be designed *in situ*. Implicit, and often explicit, in many participatory planning approaches is the adoption of the 'subsidiarity principle', that governance and management of natural resources should be done at the lowest appropriate level. The two, stakeholder participation and subsidiarity, come together in Dublin Principle No.2.[5]

A good starting point for designing a methodology for participatory drainage planning is the detailed procedure for achieving co-management of natural resources as described by Borrini-Feyerabend et al. (2000).[6] Co-management is "a situation in which two or more social actors negotiate, define and guarantee amongst themselves a fair sharing of the management functions, entitlements and responsibilities for a given territory, area or set of natural resources" (ibid.:13). The approach has three phases, preceded by a point of departure, and steps within these. The tree phases are: (i) preparing for the partnership; (ii) negotiation of plans and agreement; and (iii) learning by doing, (Abdel-Dayem et al 2003). The functions and values analysis and assessment procedure as described above, would be part of all phases. It would thus be an integral part of the overall participatory planning approach.

Central in this approach from an institutional or planning perspective is the *negotiation* of options and strategies by the concerned stakeholders. An interesting feature of the approach is that it specifies the basic conditions under which co-management, and by implication participatory planning more generally, can work. These include "full access to information on relevant issues and topics, freedom and capacity to organize, freedom to express needs and concerns, a non-discriminative social environment, the will of partners to negotiate, and confidence in the respect of agreements: (ibid.:13). In very few situations, if any, these conditions are completely fulfilled. Participatory planning is not just a methodology; it is a political process in which different interests need to be balanced. This requires a repertoire of strategies for the empowerment of excluded and underprivileged stakeholder groups, and methods of conflict resolution.

Participatory Planning for Drainage

To design participatory planning approaches for the DRAINFRAME tool the following questions need to be answered.

1) Which methodology (phases, steps, techniques) will be adopted for participatory planning of drainage interventions?
2) How will civic engagement in the different phases of the planning and management cycle be enhanced, and how will excluded and/or underprivileged groups be empowered / empower themselves to be able to participate on reasonable terms?
3) Which are the locations and situations that would allow experimenting which such an approach with a reasonable chance of success (that is, are there situations with a favorable or enabling environment for participatory drainage planning)?

The Institutional Dimensions of Drainage: Governance, Management and Finance

The starting point for enhancing institutional performance and/or institutional reform is quite different in different contexts. Three trajectories of drainage development can be distinguished: (1) focussed government initiatives, (2) spontaneous development of drainage through local initiative, and (3) incomplete or stagnating drainage development. The importance of local user initiatives may be underestimated because underreported in developing countries, and would merit closer study. The more common is the situation in which drainage received limited attention and priority, and leads a fledgling existence. Different mechanisms and strategies will have to be found to put drainage on a firmer footing. There are considerable hurdles in the present governance framework to make local users organisations effective on a large scale and new forms of regulation are required. There is a need to pitch 'integrated' drainage organisation at a higher level than the local users groups.

Governance Themes

Different as these three trajectories are, a number of recurrent themes characterize governance in drainage. The *first* theme is that in many countries the agricultural community has been the main constituency. Other constituencies, be they environment, health, or the protection of buildings and roads, have been less articulate. In case of user-initiated drainage land developers generally took the lead. Government-initiated programs have often strongly identified with agricultural objectives – food security or agricultural land settlement. The non-agricultural functions of drainage have received little institutional attention, and the know-how to

[5] The Dublin Principles can be found on the Global Water Partnership website (www.gwp.org).

[6] The document is downloadable from www.ecoregen.com/com/share_ex/uploaded/man_Nat.pdf .

serve other functions is not well developed. Governance has been single center rather than polycentric with limited roles for other players, either in other sector, in local government or civil society.

A *second* theme is that in many countries a strong drainage sector has not developed. This also applies to countries that have had considerable drainage investment, either public or private. In countries where the government has taken the lead much has been done in-house and a service sector outside the public sector has not emerged. In several countries in Asia and Africa where users have developed drainage systems the public sector has latter neither regulated nor supported user-initiated drainage. Private sector service activities or the role that civil society plays are often weak.

A *final* theme is that - with the exception of a few counties, managing drainage through improved overall water resources management is anything but mainstreamed. Similarly the finance of drainage has received little attention. This is most obvious in those countries where the management of shallow water tables and removal of surface water has not come off the ground at all. But even where there has been substantial development of drainage infrastructure, the operation and maintenance of drainage systems has received very low budget priority, undoing many of the positive effects and creating environmental or health hazards instead.

Management at Higher Scale Levels than System Level

We have argued that drainage should be planned at landscape level rather than at system level only, as is common practice today. This point is consistent with the emphasis in current policy discourse on water resources management at higher levels than the individual water control system, that is, at the sub-basin or basin level. In the case of drainage it is easy to see the value-added of natural resource management at landscape, hydro-ecological region, sub-basin or basin level – whatever unit is appropriate in a given situation. Several processes can only be managed at these higher levels.

Drainage and *flood management* are strongly linked at basin level. Drainage congestion is often a major cause for local flooding, stagnating water and high water tables. The impact of the construction of roads, residential areas, polder embankments and other infrastructure on drainage patterns is often underestimated and not addressed.

In arid areas such as Pakistan and India, drainage problems are often stereotyped as 'irrigation-induced'. Yet, for all the attention to water scarcity in recent years, there has been little systematic effort at including drainage in improved water management at command area or landscape level.

A third interaction at basin level is the role of drainage in managing key *ecological processes*. Drainage can provide opportunities for the maintenance or restoration of processes that are essential for the functioning of certain landscapes when it is considered as a tool for shallow water table management and removal of excess surface water (as the definition of drainage above implies).

Finally, drainage management at landscape, hydro-ecological region, sub-basin or basin level has a large bearing on *water quality*. The cleansing capacities of wetlands may either be undermined or protected, depending on the way shallow water tables are managed.

However, caution is required in equating the need for integrated water resources management at the basin or landscape level with a recommendation to establish river basin organizations. Equal caution is required in recommending 'leapfrogging' to river basin management/organizations in the contexts that prevail in many developing countries. Rather than the blanket introduction of river basin organizations it seems that every country will have its own way forward in improving resource management at the middle level. In general, a polycentric governance structure offers much promise for drainage development and management. There would be no single, ultimate center of authority but rather a number of players with clearly differentiated functions/roles, each exercising authority circumscribed by rules (Ostrom, Schroeder and Wynne 1993).

Establishing User Organizations in Drainage

Strengthening user organizations is a recurrent theme in water resource management, particularly in countries where drainage programs were primarily initiated by governments. Existing examples suggest that establishing local organizations of a scale similar to that of Water Users Associations in participatory irrigation management programs (from which the organizational models for local drainage organization are sometimes derived) is pitching the unit of organization too small. There seems to be a logic for a medium-level form of organization. The service area must be large enough to generate revenues, and the management tasks must legitimize the cost of running an organization. It would be at this level that irrigation *cum* drainage or flood control *cum* drainage could be managed by the same organization.

Broadening the Financial Basis

Financing is a major issue in drainage, as in other water sectors. The development and maintenance of drainage systems is often under-funded and conventional funding mechanisms – particularly central budget allocations – prevail. In the light of the governance discussion there is a need to take a fresh look at financing drainage. Acknowledging the role of many different players in many different sectors in drainage allows the identification of a number of new financing strategies. There is scope to revive efforts at cost sharing and cost recovery particularly by working on the willingness to pay. Low recovery is often related to users' disillusion with the quality of service. Elements of a strategy to improve cost recovery are improved service, low administrative costs for levying the fee (making assessments and billings), low costs of enforcement and collection, rewards for prompt payments, enforceable fines for non-payment and transparent procedures. With respect to the latter, users' approval of budgets is one option, as in the benefit-pay-say system of the Dutch water boards). There may also be room for innovative collection mechanisms. An example comes from some of the regulators intricate management arrangements in Bangladesh (Abdel-Dayem et al., 2003).

A case can be made to charge part of the cost of drainage management against non-agricultural functions, which, however, is not always done. In some cases it may be possible to charge non-agricultural users directly. Some effects and impacts of drainage on natural resource system functions have a general interest nature. Ecological functions are in the interest not only of presently living people, but even more in the interest of future generations. The same applies to public health, flood control and protection against dampness. In this basis it can be argued that governments should contribute to the (incremental) cost of drainage or alternatively to charge all residents or land owners equally.

Drainage is best looked at not merely as a service that needs to be reproduced, but as a central component of a resource management system that requires inputs and produces value. Part of this increased value may be captured to pay for investment, running or maintenance costs. Better utilization of the drainage infrastructure may also create economic value, which can be used to pay for essential maintenance services.

Due to the disjointed nature of governance in drainage, the public and private sector are often worlds apart. Yet in some regions there has been substantial spontaneous investment in local drainage. There is scope to rethink drainage development strategies, and to look at the development of local private sector capacity to serve individual farmers and to concentrate public investments on main systems only

Drainage Infrastructure and Operation for Multi-Functionality

An integrated perspective will have implications for the drainage technology that needs to be deployed and the operational procedures that need to be adopted to use it. The physical design and operation of many drainage systems has a long-standing bias towards agricultural productivity. Multipurpose design and operation is still the exception rather than the rule in drainage. Yet if drainage systems are to serve a variety of objectives, from land productivity, to water conservation, to water quality management, to protecting buildings, to public health, then technology design and operation needs to be done differently. This provides a major technical professional challenge. Some examples and issues are the following.

Water retention, water table management and controlled drainage: If the prime meaning of drainage is redefined as comprising the management of shallow water tables, the ability to control water table depth and drainage canal water levels is very important. It allows regulation of soil-moisture for both irrigated and rain-fed crops and enables maintaining of water levels for fisheries, to prevent land subsidence, and other purposes, and also affects soil chemistry. The concept of controlled drainage has been subject to experimentation and proved technically feasible, but the challenge is to develop appropriate low cost, easily manageable water conservation technology. A main problem is how to coordinate the different priorities of different farmers (growing different crops) in the absence of a strong local organization, that is, the ability to control water tables needs to be matched by the local institutional capacity to balance the different interests.

Flood management: Drainage and flood management need to be brought closer together at the level of (sub-)basin management, but the same is true at the level of drainage infrastructure design and operation. The capacity to store excess rainfall in the shallow aquifer is an important asset in flood management. In many cases investment in drainage infrastructure will complement flood mitigation strategies. But also drainage can aggravate floods. This happens when the network of drainage pipes and canals quickly transports storm water to watercourses and rivers and there is no facility to store or slow-down the run-off.

Management of effluent quality: The design of drainage infrastructure affects the quality of the drainage effluent. The quality of drainage water may be affected by high salinity, acidity or by chemical or bacteriological contamination. In the design or operation of drainage facilities the quality of the effluent and the possibility of mixing it or neutralizing it should be given a prominent place, but often this has been neglected. In addition to controlling pollution through using appropriate technology at the source a regulatory framework that controls the disposal of effluent from agricultural and non-agricultural sources in a drainage system is a prerequisite.

Vector control: Drainage infrastructure can have significant effects on vector organisms and improve local sanitary conditions. Yet drainage has in the past also added significantly to health problems, with stagnant water in poorly maintained drains becoming a main source of transmission of diseases. Over the years a number of guidelines and good practices have been formulated that improve drainage's positive impact on public health, but it is testimony to the isolated position of drainage that these have not been mainstreamed.

Choice of unit size: Multi-purpose drainage management raises the question of the size of the unit at which drainage is managed. Compartmentalisation into smaller units allows more or less tailor-made solutions to local water issues. This is particularly useful where local variation in drainage conditions and drainage interests is large. The downside however is that as management becomes more tailor-made and fragmented, the organisational requirements get more complicated and the cost of management increases.

Planning, design and evaluation technologies: drainage in integrated water resources management aims at linking land and water resources in the regional and river basin context and dealing with the multi-purpose drainage (crop production, water quality, landscape, environment), as well as conflicting interests of user groups (farmers, fisher(wo)men, industries and municipalities). These concepts are novel, and the implementation is not straightforward because data to support the operationalisation of these concepts is not always available and the number of variables and interactions would be far too great to be captured by the conventional methods and simple analysis. Development and operationalisation of new tools that are able to capture enough information and simulate complex hydrological and environmental processes as well as social processes and responses are needed.

Knowledge management: A fresh look at research agendas, with far larger attention to technologies and water management strategies that serve multi-functional resource use is necessary. The natural recipient for knowledge and how to effectively disseminate should be more clearly defined. At the same time there is scope to learn more from ongoing practices and allow practitioners to innovate and upgrade their knowledge. In practice this means giving room for experimentation in water investment programmes and a much stronger link between research organizations and training institutes.

The Way forward

Five main messages emerge at the end of our analysis. Some of these messages target the broad audience of professionals in the drainage and water management sector, planners, decision makers, governments and the international community. Some are specific to a particular group. These messages may help to rethink drainage policy and induce these different groups to take up their responsibility in the drive to integration.

First Message: Dare to Look at All Costs and Benefits. A general lesson from the global experience (see the case studies) inform us that there is a dire need for more effective approaches that acknowledge all *positive and negative effects* of drainage, and ensure multi-functionality (re-)design and operation of systems, apply fair cost allocation, and offer mitigation/compensation for all who experience negative impacts from drainage. This would provide incentives for mobilization of resources for investment in 'integrated' drainage.

Second Message: Emphasize the Potential of Poverty Reduction in the Integrated Approach. Ignorance about many functions of water and land, and the interests at stake, are among the root causes of unsustainable drainage, and cause of poverty for many. The increased costs because of the loss of functions of the natural resource system reflects the potentially poverty deepening effects of having or missing drainage (World Bank. 2002). The two-sided effects of agricultural drainage on poverty make it imperative that planning simultaneously addresses both sides of drainage. The proposed integrated approach fosters the poverty reducing effects of agricultural drainage.

Third Message: Move Towards an Integrated Approach with Pragmatism and Vision.There is little experience with the implementation of drainage following the concept of multi-functionality, especially in developing countries. This makes it difficult to make big steps towards a significant paradigm shift. A steady step-by-step approach for change, including the transformation of policies that govern drainage management and development, is preferred as a pragmatic way for achieving change (World Bank. 2003). Nevertheless, a paradigm shift towards integrated drainage is required and offers an opportunity not only to address the well-known side effects of the technology, but also to overcome major problems of classic agricultural drainage.

Fourth Message: Learning before Doing. Change should start by improving knowledge. For the first critical steps towards new policy, in a scene of diversity in all respects and little experience with new approaches, understanding each drainage situation and its specific needs is indispensable and comes before action. Experimentation and piloting the integrated approach as the one presented by DRAINFRAME in the context of local diversity is a crucial first step towards formulating policies and guidelines, and for planning drainage interventions.

Fifth and Concluding Message: An Important Role for Governments and the International Community in Promoting an Integrated Approach to Drainage. Part of governments mandate is to promote development and change and to provide the instruments and enabling environment to make this happen. The international community comprises important players in the fields of water management, agriculture and rural development, water supply and sanitation, social development and environment. They manage strong knowledge bases and many research centers. They could provide great opportunities to promote the proposed integration in drainage. As change agents they can push policy development and innovation processes in drainage investments.

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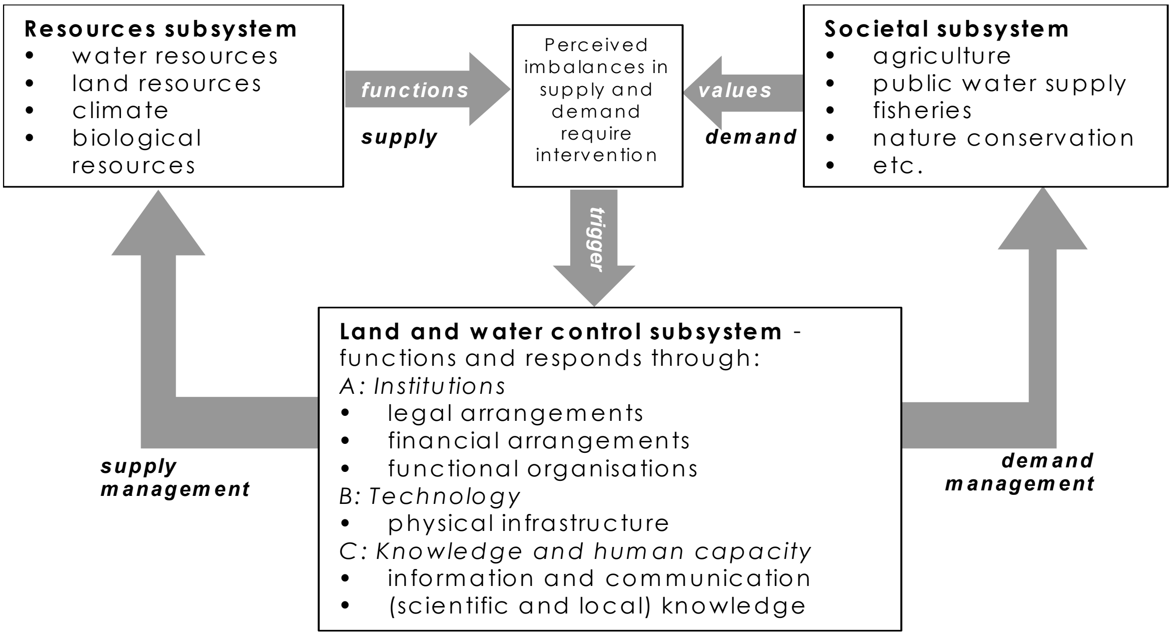
Figure 1: The three subsystems of the socio-ecological system: the resources subsystem, the societal subsystem and the land & water control subsystem.



Source: adapted from Slootweg, Vanclay and van Schooten (2001)

Figure 2: Stepwise, iterative analysis of (proposed) drainage interventions