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Service Oriented Management and Multiple Uses of Water in modernizing Large Irrigation Systems

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20 large irrigation systems (average system size is 171.000 ha) mainly in Asia are scrutinized for multiple uses, functions and purposes. Most of them have been investigated by FAO as part of its program on irrigation modernization. The concept of Service Oriented Management (SOM) is central in the latest developed approach, called MASSCOTE [Mapping Systems and Services for Canal Operation Techniques]. This SOM approach on irrigation systems paves the way to identifying multiple uses and functions of water services within the gross command area of these systems. Analysis shows that only two systems out of 20 can be classified strictly as single use, all the other systems, are dealing, with varying degree, with multiple water uses, multiple functions, and/or externalities within their command area and therefore can be qualified as medium or high Multiple Uses of Water Services (MUS) system. Not many irrigation systems are designed/developed for providing service for multiple water uses, or are integrating MUS in absolute terms, but not many systems rank high in service oriented management either. However many systems (7) are already following practices related to MUS, only 6 systems have low MUS integration. It is found that the higher the degree of MUS the higher the integration of SOM in the management. High SOM level goes always with high integration of any other use when practiced in the command area. For some low SOM systems integration of MUSF in the management is still made at a similar low level as the one practice for crop water services.

Introduction: Approaches on Multiple Uses and Functions of water services

Multiple uses of water is attracting an increasing attention of decision makers and water professionals from different perspectives, domestic water and irrigation of course, but also power generation, environment and tourism, etc. Generally speaking Multiple Uses of water services (MUS) has been for long, and still often is a de facto and sometimes unknown practice that has been exposed as a result of studies carried out to address concerns regarding water services provision to poor people and farmers, the impact of irrigation development/management on eco-system (externalities of irrigation development) and the issue of low performance on irrigation systems. The three main approaches that have been helpful in addressing the above mentioned concerns and revealing the existence and extent of MUS are: the livelihood approach, the ecosystem services approach and the service oriented management approach. These approach reflect also the various scales of MUS dimension respectively the household, the catchment and the scheme.

The livelihood approach revealed how much especially poor people can benefit from using water in multiple ways from the same infrastructure to satisfy basic needs that would cost a fortune to satisfy by other means (van Koppen B. et al, 2006, Renwick M. et al, 2007). The ecosystem services approach has been historically another source for revealing in various instances the high value of multiple uses (positive externalities) when it is threatened to merely disappear. A good example of such an ecosystem services approach is the paddyfield cultivation the multiple values of which have been (re)-discovered and documented when this agriculture practice has been seriously jeopardized on the solely basis of rice economic, abundant examples of that exist in Asia but also in other parts of the world. Another good example of this concern is modernisation of irrigation techniques at field level and the risks associated to other uses when water losses are effectively reduced or eliminated as a result of the program. For instance in south of France this recognition has led in the 80s to specific modernization programs maintaining a high proportion of surface irrigation at field to avoid the depletion of groundwater highly dependant on deep percolation from irrigated fields (Renault D. 1988) and which are the sole source of domestic water to some towns during summer.

Similarly to what has been done in the Millennium Ecosystem Assessment, ecosystem services related to water can also be divided into the following types: Provisioning, Regulating, Cultural and Support services (see CA 2007 Chapter 6). Irrigated paddy cultivation is practiced in what is classified as a “manmade wetland system” which yields to multiple values in many dimensions as shown in figure 1.

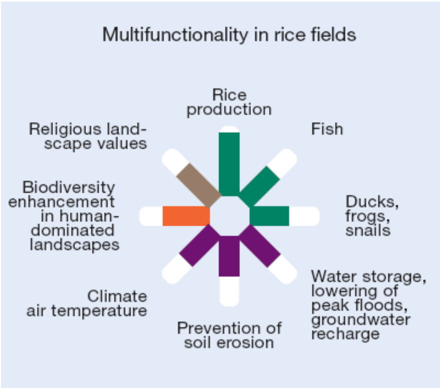

Figure 1 Ecosystem services in rice fields (Extracted from Chapter 6 CA 2007)

The service oriented management (SOM) approach applied to large irrigation systems as part of an irrigation modernization strategy also clearly reveals the various uses and users “beyond the crop” and beyond the farmers. In medium and large irrigation systems the concept of multiple uses of water which was neglected or even sometimes rejected, has gain momentum during the last decade as the result of SOM. The necessity to improve service to users and to progressively balance the account for operation and management has led managers to cense more carefully uses and users and ultimately the potential payers of the services.

Drastic revisions of the notion of services and users have resulted, and irrigation managers are now keener to face the reality of their multi-sectoral business. They are progressively abandoning some of the theoretical “fiction” on which irrigation infrastructure has been developed initially such as “imposed cropping pattern”, “single use”, etc. MUS in irrigation systems is clearly the result of the principles of reality and of service oriented management.

This paper relates to Service Oriented Management approach and Multiple Uses and Functions of Water services, analysing the experience gathered recently on FAO modernization projects on large irrigation systems.

Mapping System and Services for Canal Operation Techniques

The Land and Water Division (NRLW) of FAO initiated in the mid 90s a program on modernization of irrigation management with a particular focus in Asia. As part of this programme, various tools and methodologies have been used to develop the capacity of the irrigation engineers in the region. The most recent approach (FAO, 2007) is called “Mapping System and Services for Canal Operation Techniques” (MASSCOTE). It integrates/complements tools such as the Rapid Appraisal Procedure (RAP) and Benchmarking to enable a complete sequence of diagnosis of external and internal performance indicators and the design of practical solutions for improved management and operation of the system.

MASSCOTE aims to organize project development into a stepwise (see Table 1) revolving frame including:

- mapping the system characteristics, the water context and all factors affecting management;
- delimiting manageable subunits;
- defining the strategy for service and operation for each unit;
- aggregating and consolidating the canal operation strategy at the main system level.

Table 1. MASSCOTE STEPS	
Mapping	**Phase A – Assessing baseline information**
1. The performance (RAP)	Initial rapid system diagnosis and performance assessment external and internal indicators
2. The capacity & sensitivity of the system	Physical capacity of irrigation structures to perform their function of conveyance, control, measurement, etc. Sensitivity of irrigation structures in reacting to input changes
3. The perturbations	Perturbations analysis: causes, magnitudes, frequency and options for coping.
4. The networks & water balances	Main features of the irrigation and drainage networks, Water balances at system and subsystem levels.
5. The cost of O&M	Costs associated with current operational techniques and resulting services.
Mapping	**Phase B – Vision of SOM & modernization of canal operation**
6. The service to users	Mapping and economic analysis of the potential range of services to be provided to users.
7. The management units	Management organization in units and sub-units
8. The demand for operation	Resources, opportunities and spatial demand for improved canal operation.
9. The options for canal operation improvements / units	Improvement options (service and economic feasibility) for each management unit for: (i) water management, (ii) water control, and (iii) canal operation.
10. The integration of SOM options	Integration of options at the system level (cohesiveness check).
A vision & a plan for modernization	Consolidating a vision - finalizing a modernization strategy

Service-oriented management in irrigation: revealing MUS

Service Oriented Management is a managerial approach that focuses on the supervision and control of the delivery of a service from a service provider to a service requester. In irrigation management, the latter is called a service receiver. The three pillars of SOM are the service itself and the two actors – the provider and the receiver (or user and beneficiary) – as illustrated in Figure 2.

The actors of the service

In business language, receivers are considered customers or clients. In an irrigation system, receivers are these but also actors or stakeholders of the management through effective participation in the governance of the scheme. For example, in a Water User Association (WUA), farmers are not only the customers of the service, they also are involved in the decisions about it. In this sense, the farmers are also actors.

The elements of the service

The first element is the water. Water delivery is central in the service, but it is not the only important component. Information is also an important element of the water service. Information flows in both directions, from providers to receivers and vice versa. Users need to have information about the allocation of water, the scheduling of supply, and about measurements of deliveries. Money is also a critical element of the service approach. The bill for the irrigation management services has to be paid by someone, now or later, for own use and for someone else. Therefore, it is a major responsibility of the management to organize effectively the flows of money for covering the cost of producing the services .

Indeed, the service consists of three main flows: service = water + information + money which are intrinsically linked to each other (Fig.2).

Defining services to users

The diagnosis of MUS in a command area of an irrigation system does not proceed from a priori methodology but is clearly and without doubt the consequence of the approach of Service Oriented Management. The compulsory focus on services leads to uncover the multiple uses when they do exist.

Irrigation systems were originally built to supply farmers with water where crop requirements could not be met by natural precipitations. Thus, service to farmers has been and should still be the central focus of the management. However, over time, it has become increasingly apparent that other beneficiaries besides farmers are taking advantage of irrigation water supplies for uses other than crop production, which of course may sometimes conflict with irrigated agriculture. The services to users are today much broader than at the initial stages of irrigation development although water demands by farmers are still the central focus of management and agriculture often remains the main consumer of water.

Diversifying services for agricultural uses

Many irrigation systems have been designed to supply the same water service to farmers throughout the entire command area, considering quite uniform needs for water based on assuming uniform conditions of crops, soils, local water access, etc. However, we know much better now that agricultural demands are not homogeneous. Some physical conditions differ from one location to the other, access to alternative source of water varies highly in a command area. Furthermore in most of the irrigation systems diversification of cropping patterns has largely occurred since inception time. The demands of an organic farming community, growing vegetables and flowers, will be very different from uniform rice-based smallholder systems, which are again quite different from large cotton or sugar-cane estates. Their irrigation requirements will not only be different in terms of all performance variables, but their water demands will also be based on considerable differences in irrigation techniques, labour requirements, economic returns, vulnerability to service failures, bargaining power, status, gender divisions, etc. Crop water requirements for the different crops and varieties will be the basis of any irrigation service demand, but they are not the only rationale in farmers' irrigation strategies.

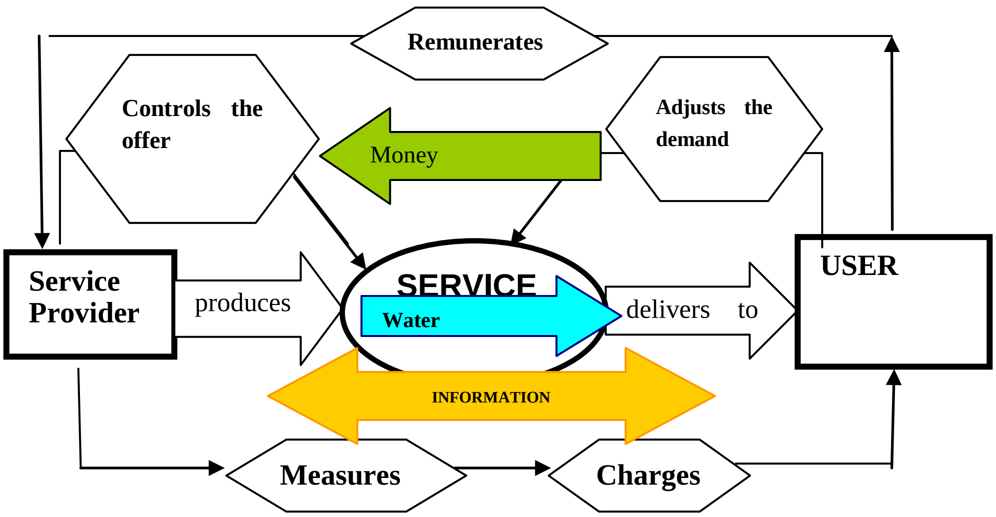

Figure 2. Sketch of Service approach with the 3 basic flows: Water (blue), information (yellow) and Money (green) [After Renault and Mountginoul, 2003].

In summary, it is important to remember that the demand for irrigation services even for the same type of users (farmers) is heterogeneous in time and space within a command area. The motto for modernization and SOM is then to define the right service at the right cost to each use and with each user.

Provision of service for other uses

The above-mentioned various additional uses and specific needs related to water management require different types of water service, ones that differ from the service for crop production. These extra services are context-specific, sometimes simple and at other times complex; they need to be discussed and tackled locally. The services for other uses might be of the following types:

- Supplying water to a delivery point
- Maintaining flows in local streams and waterbodies
- Maintaining water levels in local waterbodies
- Maintaining water quality in natural streams
- Maintaining the capacity for storing water and control floods

Types of operation required for multiple services

In theory, the basic physical operation of gates in the system is the same for providing any type of service. However, the process of decision-making and planning for these activities may differ from that of farmers and canal managers.

An important aspect of operation for these "other uses" is planning and allocation. Canal managers need to know the water demands and requirements, as well as available resources, for these different users in order to be able to allocate water properly for these activities.

The multiple uses can sometimes conflict with one another and there is a need to compromise when the operation requirements are antagonists.

Table 2. Type of target and service for different uses	
Use/function	**Type of service / target**
Delivery to farms	A time (and volume) bound water delivery A share of flow
Domestic water	Bulk water delivered [Discharge or volume per period]
Drinking water for cattle	Water supply to small ponds. Construction of ramps on canal side to ease access to water.
Support/recharge to natural surface streams (surface and groundwater) & environment	A specific discharge to outlet Water presence in canals and at field (seepage and percolation) Water quality through water dilution and/or drainage control
Industry and Hydropower	Discharge and head availability. Water supply to small ponds for small industry
Tourism, fishing, recreation, wild animals & natural parks	A water presence & a given water level in waterbodies
Control of vector-born diseases in waterbodies	Water-level fluctuations
Flood control	Water storage capacity
Control of drainage return flow	Maximum discharge

Analysis of 20 large irrigation systems with respects to MUS

A set of 20 medium to large irrigation systems mostly in Asia, totalling a Gross Command Area (CGA) of 3.4 Million ha, probably hosting more than 10 millions of inhabitants have been considered in the analysis. 18 of these irrigation systems have been directly investigated through RAP and MASSCOTE by FAO since 2004, the size of the gross command area varies from 13,000 ha to 540,000 ha with an average of 171,000 ha. All systems qualify as large systems with the exception of two having a GCA below 25,000 ha which for Asian standards is considered as medium.

Two medium size systems, one in Sri Lanka the Kirindi Oya Irrigation System, and one in France, the Canal Saint Julien, have also been included in the study because they are both well documented and can serve to a large extend as references on MUS in many ways.

The analysis of the 20 systems has been first carried out considering a typology approach the features of which are presented in table 3. Results against this typology are mentioned in table 4 column 4 for multi-purpose and column 5 for the multiple uses. The ecosystem dimension and the multiple functions are addressed on column 19.

Important to note that the set of systems cannot be considered as representative of irrigation in Asia as 15 out of 20 systems are from South Asia. The paddy systems, dominant in South Asia, are under represented here, only 3 systems are rice based partly or totally.

Out of 20 systems 8 are considered Multiple Purpose Reservoir while 5 systems are Multiple Purpose Network, 10 systems are classified as MU + , 7 are considered as MU Seq and 3 are MF (total is more than 20 as some systems are exhibiting several types). Only 2 systems are classified as true Single Use of Water, namely Jamiakou in China and Naryani in Nepal. In both cases domestic supply if well provided, through a separate network in Jamiakou, through the presence of shallow groundwater in Naryani.

Table 3. Classification of MUS per type			
TYPE		**Sharing**	**Typical situation**
MPR	Multiple Purpose Reservoir with separate networks	Reservoir	Reservoir used for irrigation, environment, domestic and flood control.
MPN	Multiple Purpose Network based on a single distribution infrastructure	Network	Main canal serving cities, irrigation, industrial sites, environment,...

MU +	Single Use distribution network yielding opportunities and externalities for other uses.	Water resource & Network	Domestic + Irrigation +
MU Seq	Sequential system: drops cascading from one compartment to the other, one non consumptive use to the other.	Water cycle/pathwa y	Conjunctive use of water System with recycling (re-use) facilities
MF	Natural Multi dimension/functions/services	Territory Eco-system	Paddy Field system Wetlands

How SOM and RAP-MASSCOTE reveal Multiple Uses

In the following sections, we examine some of the criteria and outputs of RAP/MASSCOTE applications and illustrate how a SOM approach leads compulsory to the identification of Multiple Uses and Functions of water services when they do exist. First of all RAP/MASSCOTE exercises by putting “Services” as a plural reverse the common trend to consider one single use of water (irrigation). In that sense the considered norm is MUS and the exception is Single Use which has to be proved. This radical attitude is usually supported by various aspects of the managerial investigation that can point out on the existence or not and the importance of MUSF. Among many:

- Water balance (MASSCOTE STEP4) is a fundamental critical entry point for management which allows mapping down the water consumption by the irrigated crops and non-crop elements (other uses). This is a critical step in asking where do the water goes, to which uses and users? It is always striking to see how managers are flabbergasted when they discover the low share of crop water consumption and inversely the high share of other uses.
- Field survey (during the application of RAP/MASSCOTE) allows assessing the degree of perennial vegetation (natural and home garden) in the command area and by comparing it with non irrigated near by areas to estimate the possible contribution of irrigation water to sustain non crop vegetation (for productive purpose and biodiversity).
- Field survey can also reveal activities which are water dependant, such as fishery, small industry, recreational, tourism, etc...
- Presence or not of separate domestic water network is also a good indicator of the reliance of people on irrigation water to support other uses than crops in particular drinking/domestic water and cattle.

Degree of MUS

The degree of MUS has been analysed for each system of the set by adding the number of different uses that have been reported in the RAP/MASSCOTE. It is equivalent to the number of dimensions shown in figure 1. It does not express though the magnitude of the multiple uses which should be assessed through more detailed analysis of the water balance and/or the various values generated by the different uses. Only few systems are enough documented to reach that level of understanding.

The maximum degree recorded is 7 for Kirindi Oya IS. The irrigation systems can be grouped in 3 categories:

- Single Use: 2 systems
- Medium MUS (degree between 1 and 3): 14 systems
- High MUS (degree>3): 4 systems

Table 4. Features of Multiple Uses reported in the sampled systems

C olumn 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
System	Country	GCA (ha)	Multi-Purpose	MU type	Conjunctive-Recycling	Irrigation as % water input	Hydro-power	CITY & Industrial	Dom. Villages/Cattle	FISH	TREES & Afforestation	Environment	Flood protection	Tourism Recreational	DEGREE of MUS	SOM	MUS in Mgt GCA	Comments/Functions/Externality
Gathapraba GLBC	India	180000		MU + MU-Seq	YES	54	YES	Margin	YES						2.5	1.3	2.0	High Conjunctive Use
Badra	India	162000	MPR	MU-Seq MF	YES	57	YES	YES	YES	YES		YES		YES	6.0	1.0	2.0	Paddy cover 1/3 of CA - Domestic water raising
Hemawathi	India	265000	MPR	MU-Seq MF	YES	70	YES	YES							2.0	1.1	2.0	Paddy covers 40 % of CA - TREES important
Almatti LIS	India	87400	MPR	MU +		52				YES	YES	YES			3.0		2.0	New system: MUS to build up
Gondorinala	India	13516		MU +		45				YES		YES			2.0	1.3	3.0	New system: MUS to build up
Benniethora	India	25863		MU +		65				YES		YES			2.0	1.0	3.0	New system: MUS to build up
Jaunpur	India	542000		MU + MU-Seq	YES	54			YES	YES					2.0	1.2	1.0	Raw water supplied to tanks for cattle
Doukkala	Morocco	104300	MPN	MU + MU-Seq	YES	35		YES	Margina						1.5	2.3	1.0	Supply city of Safi
Jordan Valley IS	Jordan	42000	MPR MPN			999									1.0			Domestic water to capital Amman
Sunsari Morang IS	Nepal	107400	MPR			25			Marginal						0.5	0.7		
Naryani IS	Nepal	37400		SU		26									0.0	0.2		Indirect impact on arsenic issue due to poor services
Gohthki	Pakistan	518000		MU + MU-Seq	YES	87			Margina	YES		YES			2.5	0.9	1.0	Irrigation canal used as sewage system/garbage disposal
Jamrao	Pakistan	411903	MPN		YES	80			YES						1.0	1.4	2.0	Irrigation used as sewage system
Akram Wah	Pakistan	229395	MPN		YES	77		YES	YES						2.0	1.0	2.0	Contamination from industry
Fuleli Guni	Pakistan	419379	MPN		YES	83		YES	YES						2.0	0.8	2.0	
Jiamakou	China	22000		SU		0									0.0	2.9		Separate Domestic supply network
Sanganhe	China	41333	MPR			15		YES							1.0	1.6		Main reservoir contribute to Beijing water supply
Zanghe	China	173000	MPR	MU +			YES	YES	YES			YES	YES		5.0	2.9	4.0	Negative ext. on donwstream lake
Canal Saint Julien	France	10000		MU +		0		YES	YES		YES	YES			4.0	3.7	4.0	Canals buried in cities - Delivery to Garden
Kirindi Oya IS	Sri lanka	25000	MPR	MU + MU-Seq MF	YES	50		YES	YES	YES	YES	YES	YES	YES	7.0	1.0	3.0	PADDY dominant - Negative ext. to coastal lagoons Dom. supply integrated in management practice

SOM Indicator

An indicator has been specifically defined for this study to capture the degree to which Service Oriented Management is conceptually incorporated and practiced by irrigation managers. This indicator has been derived mostly by aggregating internal indicators of the Rapid Appraisal Procedure. The rationale is to capture the extent to which the three flows defining the service (see Figure 2) are well incorporated in the management.

$$SOM = Water * Money * Information$$

The "water" indicator is calculated as a weighted average of the "water measurements" indicator to the individual ownership units and the quality of delivery from the reported indicators of flexibility, reliability and equity.

The "money" indicator has been calculated by multiplying the indicator for budget coverage of Management Operation and Maintenance (MOM) from RAP multiplied by a factor between 0.5 if this budget is entirely covered from state budget and by 1 if it is entirely covered by users. This weighting factor was added to reflect the flexibility between the service users and the payers.

The "information" indicator is calculated aggregating indicators of institutional development (WUA) and communication related to canal operation at various levels.

Finally the SOM indicator is then taken as the average of the above 3 indicators. The results are displayed in column 17 of table 4. On a scale of 1-4 the median SOM indicator is 1.1 which appears to be very low by any accounts [range 0.2 and 3.7]. This is a clear indication that SOM has a long way to go to become a well spread practice.

The SOM indicator and performance of irrigation system in terms of gross production per unit water ($ US/m3) are well correlated [Perf ($US/m3)= 0.4xSOM-0.24 with R^2=0.78] which means that high value systems go with high SOM practices.

Integration of MUS in the management

The integration of MUS in the management has been evaluated by ranking between [0] and [4] the management attitude towards MUS as described in table 5. One important aspect of the ranking is the differentiation between what is stated or recognized by managers and what is actually practiced at local level. This differentiation is a common approach is the RAP exercise aiming at evaluating the gap between central management and field practices. The ranking of MUS integration accounts for that as stipulated in the Table 5. For instance moving from an indicator of 1 to 2 corresponds to a change of practice at local level not from the central manager attitude.

The multipurpose dimension of the systems have not been accounting for here as it is normally expected that integration should reach a high value [3 or 4] for the multiple uses they have been designed for. In system which classifies as multipurpose (MPN and/or MPR), the degree of integration is evaluated only for the additional multiple uses. Results are:

- High integration i= 3 or more 5 systems
- Medium integration i=2 7 systems
- Low integration i=1 3 systems
- No or very low integration 3 systems (some of these systems are multipurpose)

The two single use systems are not accounted in the above partition.

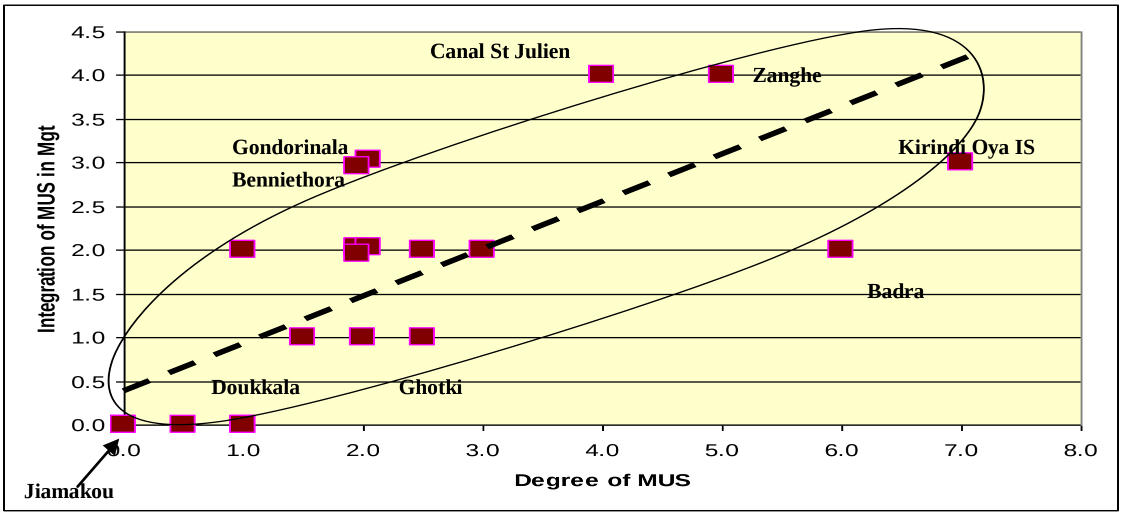

Figure 3. Degree of MUS recorded and integration in management

Relationship between degree of MUS and its integration in management

In figure 3 we plotted the assessed indicator of integration of MUS as a function of degree of MUS. There is clearly a positive trend between the two: the higher the degree of MUS the higher the integration of MUS in the management.

Relationship between SOM and MUS

Last analysis performed on the indicators is about the relationship between the level of SOM and MUS integration. Results are displayed in Figure 4. Of course these two indicators are as expected somehow independent. High SOM does not necessarily mean high MUS and vice versa. Still interesting lessons can be learned and some affirmation can be drawn from the analysis of SOM vs MUSF.

- **Affirmation 1** When SOM is high, existing MUS is integrated. This can be seen looking at system with SOM indicator greater than 2.
- **Affirmation 2** Low SOM can still go with relatively high MUS integration. In that case it means that the various multiple uses of water are somehow treated in the same way as water delivery to crops. This is in particular the case of the paddy system in Kirindi Oya IS.
- **Affirmation 3** Management attitude matters. Despite the fact that Gondorinala and Bennithora systems are brand new and still under development with no evidence of MUSF as yet, these systems are ranked high for MUS integration (3) because the manager immediately after the RAP/MASSCOTE exercise has incorporated MUS in its concerns and management interventions in particular on monitoring water flows throughout the command area.

Table 5. Ranking of integration of MUS

Indicator value	Management attitude	Manager attitude [as stated]	Local level operators and local practices [as seen on the field]
0	Ignoring or denying MUS and/or its magnitude	"There is only one single use for irrigation"	
1	Blind eye on MUS practice by users	Manager is aware of some MUS related practices but do not consider them as part of his job.	No intervention to reduce direct pumping from canals No particular concerns about groundwater pumping No intervention to prevent use of canal as a waste disposal.
2	Positive marginal practices to support MUS		Local operators accommodate in their day to day practices the other uses of water. e.g. letting unfixed leakages to drainage when water is used by downstream people/villages. letting unauthorized gate flowing into near by small tanks or drainage.
3	Integration of other services concerns into the operation	Manager knows and organise the management to serve other uses or to ensure that operation for irrigation do not penalised the other uses.	Bulk water deliveries to villages tanks Main canal filled with water after irrigation season to provide water to people in the GCA. Local reservoirs managed to account for other uses. Minimizing period of canal maintenance.
4	Integration of Multiple Uses Services into the management and governance.	MUSF is fully integrated in the Management Operation and Maintenance. Governance is made on the basis of multiple services with multiple users/stakeholders.	Each service well defined. Users well identified, they pay for the services, they have a say on decisions on the system management.

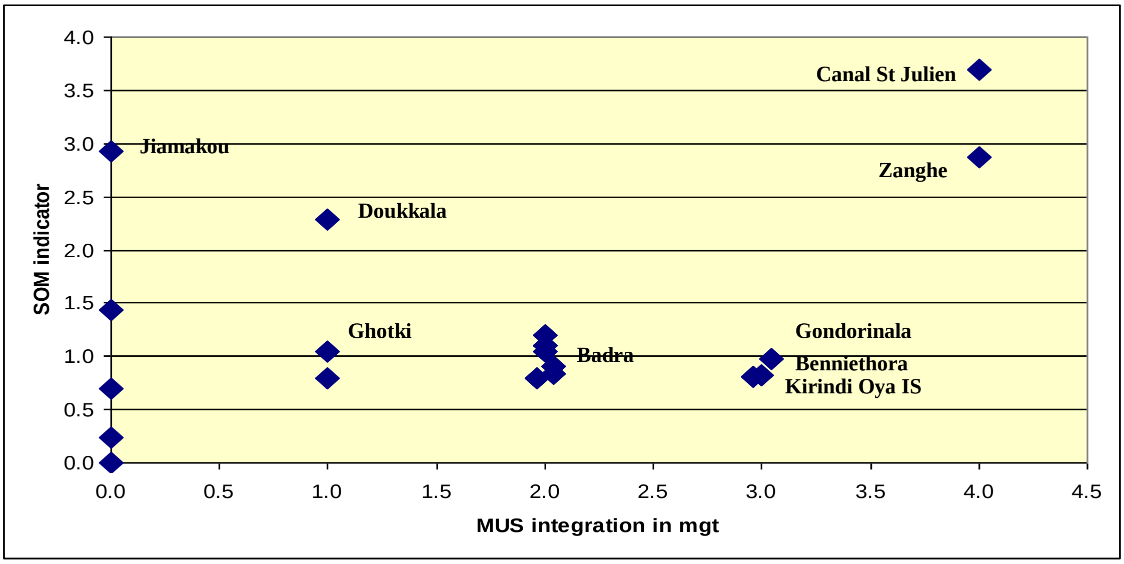

Figure 4. MUS integration and SOM practices

Table 5. Insights from some systems

System	Interesting features for SOM and MUS
Kirindi Oya IS	**High MUS Medium/Low SOM.** Well known and documented paddyfield system (Renault et al, 2000) almost every type of water uses, multiple functions such as tourism and flood control (paddy system) are met. Multiple values of this system has been also documented for some key components such as food and fisheries (Renwick M., 2001, Hermans et al 2006). Irrigation consumption only one third of the total water inputs - Trees grown on homestead garden and in the landscape is the more important uses of water 44 % but generates high values for the people [Coconut trees are the tree of life]. Also noticeable negative externalities to coastal lagoons as too much fresh water is drained jeopardizing the shrimp population (both a source of incomes for some people and feed for migratory birds)
Canal St Julien	**High MUS High SOM.** Well documented old canal South east of France (Canal St Julien, 2008). Only 13 % of water withdrawal is consumed by agriculture crops. The remaining 87 % are shared by Groundwater recharge – Environment: strengthening of surface natural streams – Home Gardens - Trees in cities. Cost sharing was a strong motivation to assess and manage MUS which is now well integrated into the governance and management process of the association.
Zanghe	**High MUS High SOM.** A very interesting case well documented from China (Dong Bin, 2008). Remarkable for the huge changes it has experienced. Between 1970 and 2000 water for agriculture has been dramatically reduced annually from 600 MCM to less than 200 MCM while other uses have been raised from almost zero to 450 MCM.
Badra	**High MUS Low SOM.** One of the highest degree of MUS reported, multipurpose reservoir, a large complex cascading system, paddy fields mostly at tail end, large domestic water use, drinking and washing, cattle drinking water, power production. Yet SOM is low and integration of MUS remains low.
Ghotki	**Highly reliant on irrigation water.** The system is part of the Indus River infrastructure, as first one in Sindh province Pakistan. Reliance on irrigation water is extremely high (80 % of the water inflows). Fish ponds - domestic uses - cattle drinking water, are the main other uses that are highly dependant on irrigation water flows. Urban areas are using canal systems as waste water drainage and garbage dumping facilities.

Conclusions

This article is a starting point for a further thorough review of Service Oriented Management and Multiple Use and Functions of water on large irrigation systems. The preliminary analysis of 20 of these systems, yields encouraging signals about the importance of MUS in general and on its strong relationship with the modern concept of service oriented management.

Until recently, irrigation system managers often saw the dimension of multiple services as a problem to which they are confronted or to uses which they are tolerating. However the analysis shows that things are changing, the attitude towards MUS is no longer the merely ignorance of it. Average reported attitude includes at least operational practices addressing MUS.

It is clear that the initial reluctance in considering MUS has more to do with the fact that "service oriented management" is not the current practice everywhere. Once the concept of SOM is, at least conceptually, adopted then MUS can easily be brought in. Obviously cost sharing is a strong motivation for integrating MUS. It has been known for long that the more economically sustainable irrigation systems are often Multiple Uses type, for instance associating hydropower generation and irrigation. The challenge today is to assess, value and incorporate in the operation and management various additional informal uses, externalities to and functions of water services.

Many important questions have to be answered: How to assess properly the various uses? How to value them? How to govern multiple uses system? How to operate them? How to define, produce, deliver and remunerate the water services? How to ensure water quality matches diverse needs? Obviously some issues remains to be solved; some obstacles at local and national levels have to be removed to allow more efficient and sustainable MUS in irrigation system management.

However to a large extend it also depends on the good will of the managers to embark upon MUS in a stepwise process which may include as a starting point assessing the share of water by uses, determining the values associated to these uses, setting the specific services required, as well as develop the awareness of all shareholders on MUS. Ultimately reaching full SOM and highly integrated MUS is a long term objective but significant progresses can be achieved in that end with reasonable efforts.

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