DISTRIBUTED INFORMATION SYSTEMS

FOR FARMER MANAGED IRRIGATION

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ABSTRACT

Management information systems should enable managers to make better decisions. If farmers operate and maintain irrigation systems, then inventories and other information systems should serve them, as well as irrigation agency staff and others who provide services for farmer managed irrigation. This paper explores some conceptual principles for developing efficient information systems to support farmer management of irrigation.

Information system structures should recognize that knowledge and decisions are widely distributed. Design should work back from decisions to the minimum information and analysis needed to support decisions. A modular architecture coordinated by common standards can allow information systems to evolve efficiently. Walk-throughs, water user association self-assessment and techniques for participatory rapid appraisal can help support local collection and analysis of information as part of information systems designed to support distributed management of FMIS.

INTRODUCTION

Farmers and agencies already gather and analyze much information regarding farmer managed irrigation systems (FMIS). However this information collection is often informal or embedded in other activities. The question is whether more systematic and formal information systems may improve the performance of FMIS.

Farmers may be unaware how their irrigation activities affect others within a catchment basin. They may not know how well their irrigation management compares with that in other systems and so lack a basis for assessing what opportunities may exist for improving performance. Agencies often have only very incomplete information about how many FMIS exist and how much area FMIS irrigate. Inventories and other research on FMIS have shown in country after country that the areas irrigated by FMIS are far larger than originally shown in official records. Lack of information about the extent of FMIS perpetuates policies that channel most agency resources into assisting larger government managed irrigation systems. Even when governments try to assist smaller systems, agencies may direct assistance to those systems with which they are familiar, while neglecting other needier systems. However, more information is not necessarily better, as a few examples may illustrate.

1) A questionnaire on village agricultural water resources in Thailand grew to improbable length. It was combined with an even longer national survey of other village level information, and (in part courtesy of some short-sighted internal agency politics) ended up producing information of little relevance and dubious quality.

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2) Socio-technical profiles of small irrigation systems in Indonesia and Thailand were frequently ignored in later stages of project implementation, even though they contained valuable information about local management practices and problems.

3) A carefully prototyped system for assessing village water supply needs in Thailand drew praise from government officials, but little usage, probably because provincial and district officials had little power to respond to the needs shown by the system.

4) In one Indonesian province, years of work were spent developing methods for agency staff to conduct inventories of FMIS. When a senior provincial irrigation official was asked what he saw as the most important benefit, he replied that inventories would identify sites where separate systems could be combined to use a single dam. He focused on potential technical efficiencies, with little concern for the social complexities of integrating previously independent organizations.

While these happen to be cases with which the author has some familiarity, they seem to be part of a more general pattern of sometimes disappointing and potentially counterproductive results from attempts to gather systematic information about locally managed water resources. Thus, it is crucial that the design of information systems emphasize efficiency and usefulness.

INFORMATION OVERLOAD

Government policies in many countries are giving increasing recognition and support for farmer managed irrigation systems. This requires better information about FMIS. At the same time technological changes are reducing the costs of managing information.

Photocopiers have become widely available even in small towns in much of Southeast Asia, making it cheap and easy to reproduce information. Computer spreadsheets provide a convenient tool to keep track of lists and handle simple analysis. Database programs offer even more ability to manage large amounts of data on personal computers. Information technologies will continue to deliver increasingly cheaper and more powerful ways to store, manipulate and communicate information. The convergence of policy shifts to support small scale irrigation with lower costs for storing and manipulating information should create opportunities for using information systems to improve FMIS.

However, regardless of whether information systems use paper records or computer databases, it is much easier to design forms and collect data than to set up systems that will be useful for improving decisions about FMIS. Information systems that start by simply assuming that more information must be better may well succeed in generating plenty of paper, but have little further impact. If data is hard to use, old or inaccurate, then it is unlikely that farmers or irrigation officials will pay attention to it.

Information overload may be a greater problem than information scarcity. Visits to agency offices tend to show not people desperately waiting for more data but rather people sitting at desks buried in paper. They may not have the information they need but there is no shortage of data. Indeed the abundance of data tends to bury whatever relevant information does exist. Anything produced by an inventory will have to compete to stand out in this swamp of existing documents.

Often those designing information systems, and those who collect the data, show little explicit concern with involving farmers in management decisions. Farmers are treated as the objects of data collection, rather than as managers who can be users of the information system. Usually farmers never see what happens to the information after it is collected.

Current institutional structures for financing irrigation construction and management create counterproductive incentives, encouraging excessive construction and bureaucratic expansion (Repetto 1986). By themselves information systems cannot overcome incentives created by overly centralized bureaucratic structures and subsidy oriented policies. However better information systems may be one part of reforms to improve institutions for irrigation management.

The development of information systems for FMIS is not a neutral process. Such systems can either enhance or undermine farmer management. If information about physical structures appears without the context of irrigators' organizations and water rights, then information systems may encourage ill-informed and unproductive government intervention. Many past interventions in FMIS, though usually well intended, have created unnecessary disruption of local institutions for irrigation management.

Unless carefully designed, information systems may act to undermine local autonomy and shift decisions about irrigation management away from farmers. If information systems are to avoid such contrary consequences, they need to be part of approaches which respect and enhance local competence in irrigation management.

DISTRIBUTED INTELLIGENCE

Often the design of information systems, consciously or unconsciously, assumes that the system serves a single central "decision-maker." This is particularly a problem given the diversity of FMIS and the importance of location specific information about slopes, soils, crops and village society. Most detailed knowledge is available locally. Farmers usually have strong incentives to manage FMIS well.

Rather than assuming one or a few central decision-makers it is more accurate to assume that knowledge and decisions relevant to management are widely distributed. Many different people make different kinds of decisions. Most of the decisions rely on current formal and informal information systems. Some may benefit from more formal and systematic information systems. The goal of information systems should be to enhance existing systems of distributed information, not to concentrate information and decisions in one place.

Most planning systems, in irrigation as in other sectors, work from the top down, driven more by the supply of resources from centrally controlled programs than local demand for government

Farmers

WUA leaders

Irrigation agency field staff

Irrigation agency and other government offices

Policy-makers and funding agencies

Figure 1: Potential MIS Users.

services. Even if structures exist for bottom up planning they are rarely accompanied by decentralization of authority over budgets. Thailand has an elaborate bottom up planning process for water resources development. However, requirements that projects be centrally screened congest the system. Most funding depends on agency budgets made up with little or no reference to locally initiated requests. The exceptions to this have been programs to provide funds directly to tambon (sub district) councils, which they can use for rural infrastructure works selected by the council. However district officials still tend to intervene heavily, shaping the selection of projects to serve goals of the Ministry of Interior, with limited concern for local conditions and the autonomy of local decisions. Processes such as these limit the roles of farmers and local leaders in making decisions concerning government intervention in FMIS.

However, farmers and local leaders have major roles in the self-management (Ostrom 1992) of individual WUA and are often active in intersystem management. Developers of information systems can recognize these roles and use information system development as part of strengthening procedures for more open, public decision-making in irrigation development. Such measures include greater recognition and legal support for the role of local self-management, deconcentration of agency activities to levels closer to farmers, devolution to local authorities with tax raising powers (including WUA) and methods for enabling farmers to collectively borrow funds for irrigation development.

Information systems to support distributed decisions need to serve a diverse set of users, as figure 1 shows. These include individual farmers and water user association leaders within an FMIS and may also include leaders of a WUA federation. Agency users include field staff working directly with farmers as well as managers at higher levels, particularly those making decisions about allocation of government resources. Special catchment authorities or other bodies may exist or be created to deal with both FMIS and agency managed systems relying on the same water resources.

Decision-makers at different levels have different needs regarding the accuracy, timing and level of detail or summarization of information. The design of information systems needs to take these into account rather than just assuming that one uniform database and level of reporting can serve all users. One of the key potentials of computers is the ability to customize reports according to needs. More or less detail can be included. Graphics make information much easier to understand.

Designing an information system for distributed use also means that its operation will not be dependent on only a few individuals. It requires developing simple procedures for routine use, not just for the needs of a specialized project unit. This increases the chances that the information system will outlive the end of a specific project.

Assuming distributed intelligence leads to a different view of coordination. Some coordination may occur through joint meetings or decisions by an executive. However, much more common are patterns of mutual adjustment, as people arrange their activities based on what they know about the policies and practices of others (Lindblom 1977). Information systems can help make people better aware of what others are doing, facilitating decentralized patterns of coordination through mutual adjustment. Coordination can occur on a peer to peer basis without being imposed from above or explicitly negotiated. Only when these methods are insufficient, as for example during periods of severe water shortage, may more active methods for coordinating water usage along a stream become necessary.

WORKING BACKWARDS

The goal of information systems is not to collect and store information. The goal is to deliver information which will be useful. Too often the information collected is inaccurate, irrelevant or outdated. To make information systems useful, their design has to start from the ways in which people will use them to make decisions, and work back from there to determine the information to collect.

The users of information must be identified in the process of designing and refining an information system. This also helps build a broad based constituency for the information system, rather than depending on a single high level sponsor. One of the key reasons for the failure of monitoring systems is an overemphasis on providing information that might be relevant for senior policy makers, while neglecting to provide useful information for those involved in implementation (Casley and Kumar 1987).

One tendency in developing an inventory or other information system is to start by thinking about what information to collect, without paying sufficient attention to how to use the information. This tends to result in long forms containing large amounts of information of dubious quality.

Rather than assuming that systematic information is needed about everything, it is much more efficient to assume that informal information systems will handle most information and only specific types of data need to be collected systematically. The goal is not to collect as much information as possible but instead to optimize the collection of information, gathering the minimum necessary to make decisions, taking into account the cost of collecting the information and the importance of the decisions to which the information contributes.

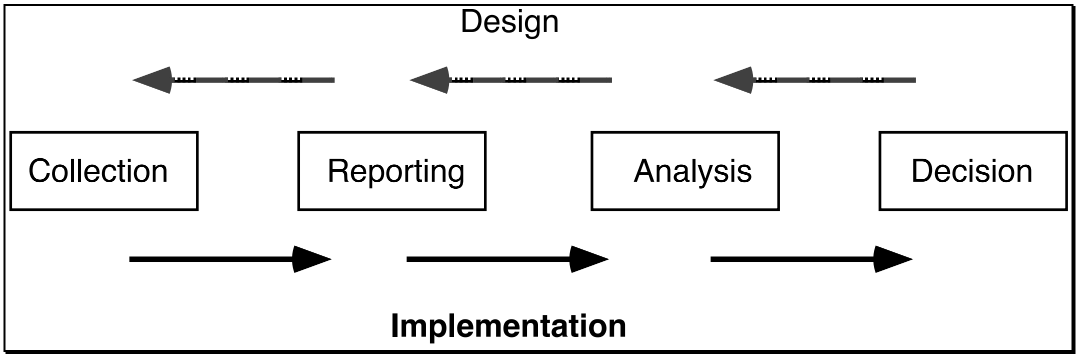

Figure 2: Information system design should work back from decisions to be made.

As in most planning, the best approach to designing an information system for FMIS is to start at the end and work back by examining what is required to reach that point. Planning should work back from the decisions to be made, to the analysis needed to make decision, the information needed for analysis and the sources from which the information can be collected, as figure 2 shows.

A major task to which inventories can contribute is coordination of water use during periods of scarcity. It is hard to facilitate equitable and efficient allocation of water among systems, without knowledge about who is using how much water and the basis for their claims to water. Inventories can give a comprehensive picture. However in thinking about information systems for intersystem water allocation it should be remembered that government officials are not the only ones who can make decisions. A federation or other forum bringing together representatives of irrigation systems may also use the information.

The needs for information to manage basin level conflicts define one set of data for an information system. Maps, schematic diagrams, water balance studies and other techniques may help display and analyze information. Visits by farmers to other systems, video recordings and other methods may be equally useful in improving shared understanding about the severity and consequences of water shortage. Thus a formal information system is at best a tool which can aid the search for ways to resolve intersystem conflicts.

Water scarcity is likely the most common problem which creates a need for information about diversions by all the irrigation systems in a catchment basin. However there may be problems with water quality, due to pollution from pesticides, mining or other sources. Deforestation and other changes in land use may affect stream flow patterns and silt levels and require an overview of conditions.

Technical and financial assistance is another major task for government support of FMIS. In theory an inventory can gather information about needs. A management information system could use this information to help prioritize needs for assistance. However such an approach could also perpetuate top-down approaches to planning which ignore local priorities and leave little room for local initiative.

Much research suggests that farmers overall do a competent job of managing FMIS. This is usually the most appropriate assumption for designing information systems and other policies and procedures regarding FMIS. The need is not for a uniform program of intervention but rather government intervention which suits the diversity of local conditions.

Assistance is likely to be more appropriate if based on responses to local requests. Those local requests may in turn be responses to announcements about the availability of government assistance. An information system can make it easier to keep track of requests. Comparative information from inventories and other sources provides one basis for assessing requests.

If authority over budget is still centralized then it is probably premature to invest much effort in improving the information systems for officials who are unable or unprepared to make decisions. Instead, the first priority would be to decentralize management and then to provide information systems to support decentralized decisions.

In practice each program has specialized needs for new information tied to the goals, level of funding, requirements for local cost-sharing and other program characteristics. Even if a "comprehensive" inventory has been carried out, new programs will probably require collecting additional information. An earlier inventory or information system may provide a useful starting point but is unlikely to be able to provide all the information needed for planning a new program.

MODULES

FMIS are diverse. They include gravity and lift irrigation. Sizes range from thousands of hectares to less than ten hectares. Water may be abundant or scarce. Management tasks differ. Rather than trying to collect a single uniform set of information on all systems, it will be more efficient to have standards for adding specialized subsets of information according to need. These can contribute to a cumulative process of building a public database of information about FMIS.

The architecture of such an information system would consist of a small common core of information supplemented by modules which contain information about specialized aspects of FMIS. The core module would consist of perhaps less than a dozen items of information, mainly concerning location. The most basic element is an identifying name or code number for individual irrigation systems. This identifying information can then be supplemented by more specialized sets of information according to need.

Collecting this core data will help address the primary issue of showing the extent of FMIS. Keeping the amount of data collected small can make an inventory faster and more affordable. Rapid appraisal and other diagnostic studies will probably be more useful than a comprehensive inventory for generating information about types of needs.

The architecture of a modular approach to information about FMIS would be a relational database with linked subsets of information, rather than a single flat uniform database.

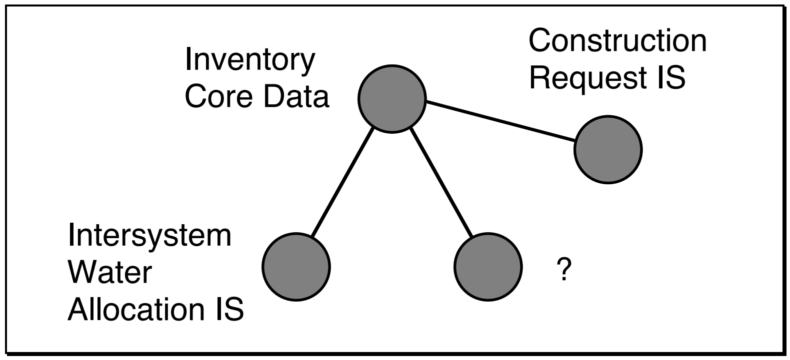

Figure 3: Architecture of a modular FMIS Information System

Information needs to be kept for different management levels, which may range from individual farmers to the national level and beyond. Different sites can keep various subsets of information, and exchange or update data using standard procedures.

A modular approach provides a way to incorporate existing information from various sources rather than having to start with a massive data collection exercise. This should be much cheaper and more practical, allowing an evolutionary, incremental approach to strengthening existing information systems.

Supplementary information could be gathered in catchments experiencing water shortages. Such a selective, modular approach to building an information system would concentrate on basins with problems, rather than spending much effort to collect information on areas where water demand is less intensive and there is little need for management changes.

A WUA federation or other body can plan and implement collection of information needed to improve water management. In some basins in northern Thailand, farmers have taken the lead in inventorying, trying to deal with conflicts concerning dry season water use, deforestation and pesticide pollution of water supplies (Uraivan Tan Kim Yong, personal communication).

Requests for assistance can be a source of information for expanding databases on FMIS. The WUA making a request provides information that can be entered into a database. Irrigation field staff who visit the system to assess the request can help check the accuracy of this information and may also be able to contribute more information about structures and other technical data.

Requests for construction of permanent dams can be linked to information about water use downstream. To accomplish this, an information system would need a way to show the relative position of a system within a catchment.

An information system can be one tool in a planning system. If it includes information about water rights it becomes more useful, but still does not eliminate the need for procedures by which those who may be affected by new construction can be informed about proposed changes upstream and receive an opportunity to have their views considered.

Irrigation management transfer or "turnover" is another example of a program with specialized information needs. Where farmers are taking on new responsibilities there may be a need for specialized monitoring of how performance changes as management shifts. This may draw on WUA self-assessment as well as observations of agency staff. Thus a module for monitoring irrigation management transfer would emphasize indicators sensitive to changes from agency to farmer management.

There may be other specialized modules of information, for example in areas where groundwater extraction is intensive enough to lower water tables and create conflicts. The approach would be one of an evolving information system rather than a single massive census. Information from different sources would accumulate in linked databases at different organizational levels. Information would then be presented according to the needs of different users.

The result of a modular approach to collecting and storing information about FMIS will be a set of databases, with a small common core and specialized subsets of additional data accumulated according to need. This fits fairly closely with current agency practices of collecting information periodically for particular projects. The difference is that if there is a shared architecture then information from different projects can be saved and re-used. Rather than starting from zero for each new activity, time can be spent instead on improving data quality.

With a modular approach the most important product of information system development is not a single massive central database. Instead the key activity is to establish a set of standards for defining and structuring data. These standards can make it possible to efficiently gather and share information among those involved in decisions about farmer managed irrigation.

METHODS

Several specific methods can enable greater involvement of farmers in collecting and analyzing information. The most familiar of these is the walk-through, already commonly used to enable designers and farmers to look at irrigation systems in the field and discuss potential improvements, including canal routing, design of structures and other specific problems.

Methods are also being developed to assist farmers in self-assessment of their activities in irrigation management (Lauraya and others 1991; Uphoff 1988). These usually focus on seasonal meetings in which WUA leaders and members review irrigation management in the last season and plan for the future. A list of topics may help structure discussion. Based on this meeting, farmers may report their needs for services to the agency. Information from forms recording FMIS requests for help can then be included as part of an agency managed information system.

Rapid rural appraisal has demonstrated that farmers can interpret maps and air photos and gain a different perspective on local resource management (Khon Kaen University 1987). More recently, efforts in India and Kenya have emphasized participatory rapid appraisal (Mascarenhas and others 1991). In PRA villagers can inventory local resources and identify resource management problems. Simple tools such as stones and sticks can display cropping calendars and other information. On the basis of their own efforts, supplemented by outside resource persons, local people can analyze problems and make plans for improving the management of local resources.

Methods for participatory rapid appraisal support learning by farmers about resource management. They could be easily adapted for irrigation information systems, or more accurately they can be part of a process of participatory development which information systems can support. They would make the collection of information a more public process and one which does more to support local management capacity. They assume that most problems should be managed locally, rather than extracting local information and then processing it somewhere else. Outside assistance is requested only for specific problems, where local capacity is lacking.

As mentioned earlier, WUA themselves can conduct inventories. Maps and scale models are valuable tools for displaying the results of inventories in ways that encourage public discussion. Overlays on maps help compare different types of information. Most of these methods can be carried out using inexpensive, easily available materials.

As the volume of information increases, computers become more useful for storing and reporting data. As computers continue to become cheaper, more powerful and more ubiquitous then computer based methods will play an increasing role even at the level of individual FMIS. The shrinking size and cost of computers make it almost certain that not too long from now they will be as widely available as electronic calculators are now. The question then is not one of availability but what tasks can be done better with the assistance of computers.

Geographic information systems (GIS) may help organize and display information about FMIS. To link system level information with GIS, latitude and longitude will need to be recorded, either from maps or using global positioning satellite equipment. GIS can help integrate information from other sources to provide a broader picture of such factors as soil types, land use, cropping patterns and other factors. GIS information, particularly that based on remote sensing, may provide information to help check the accuracy of information from field inventories and other sources, and vice versa. However, the costs and skills required to develop a GIS need to be carefully considered in comparison with the potential benefits.

Remote sensing information from satellites is becoming increasing available, though still relatively expensive and lacking detail for units the size of small FMIS. Increasing awareness of the easy international availability of satellite imagery should encourage governments to allow wider access of their own citizens to maps and remote sensing data.

Where water use in a catchment basin has been inventoried, simulation models may be used to help analyze the situation. Models are likely to be limited by the accuracy of information about soils, cropping patterns, return flows and other factors. Thus models alone will be insufficient to make decisions. Nevertheless they provide another tool for integrating information from various sources and exploring relationships. The Bali model (Kremer 1991) is an example of an attempt to show the logic of existing local institutions for managing water. An easily understood graphical interface makes the results of the model visible to agency staff and farmers.

They can explore the implications of management changes. With time, such models will become increasingly common. The need will be to encourage development of models in ways that support local decision-making in FMIS and not just exporting information and decisions to distant provincial or capital cities.

CONCLUSIONS

The overload of irrelevant, inaccurate and obsolete information is as much a problem as information scarcity. Information systems can support distributed decision-making at many levels of management, including leaders of individual WUA and WUA federations coordinating water use. Design should work back from the problems which information systems can help solve. Information systems can start from a minimal core of information, and grow through addition of specialized modules which collect information relevant to particular tasks such as basin management and planning of government responses to requests for technical assistance.

NOTES

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