Natural Resources Management (NRM)
Professor Sudip Mitra, PhD
Centre for Disaster Management & Research (CDMR)
Head, School of Agro & Rural Technology (SART)
Discipline - Agriculture Engineering
Indian Institute of Technology, Guwahati, Assam, India
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Information Communication Technologies (ICT) for Efficient Water Management

Role of ICT or information communication technology for efficient water management is a very relevant topic for managing water resources. Now, if you recall in the previous earlier lecture, we discussed about the role of information communication technology for another important natural resource soil management.

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Now, let us see that how, again ICT can be used for efficient water management. We all know that water management is very important for not only agricultural productivity, food productions, industry. Any kind of development activity water is required. So, at the same time, we also know that water is becoming many parts of the world a scarce commodity. So, that demands or requires an efficient management of water resources.

If you look at that, water scarcity affects more than 40 percent of our global population and water related disasters account for 70 percent of all deaths related to natural disasters. So, this shows that how much importan itt is to manage water in appropriate manner. And here, ICT is one

option for us, which can help us for protecting managing water quality and quantity, enabling water in availability prediction, and also maintaining aquatic biodiversity. It can also help us in assessing water supply adequacy, modelling, different supply and technology alternatives factor in different uses technologies, many ways ICT can help actually for water management.

Now, we also know we have seen that how GIS can be helpful. So I am not going to repeat that in case of soil same way for water. Now, the incorporation of different ICT tool in water management sector is very critical, because it can then mitigate some of the existing and future water issues. ICT provides an opportunity as a tool or agent of change and also an alternative method to manage this very very precious resource natural resource water.

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Now, if you look at the water management sector has different challenges over the last few decades not only for scientists, researchers, but for policymakers, technocrats, extension professionals, water users, farmers, anyone whoever is actually involved with this particular sector.

Now, what are the issues where ICT can play an important role for efficient water management? First water availability, it can actually help us it can actually inform us well in advance for a particular area, whether there will be water available for certain activity and if that information is available to various you stakeholders, they can actually plan a contingency plan how to prepare if there is no water available in the upcoming season. River pollution that also can be studied

through ICT, water conflicts, groundwater pollution, water conflicts means basically share of water resources.

And we know that whenever you talk about that, few cases comes in an Kaveri water is one of them, which we often saw in media. Then crumbling of inadequate infrastructures, which are related with water management, maybe dam and something canal, inadequate storage capacity is a major issues.

There are various areas in our country, where there is plenty of rainfall, but there is a major issue with storing that extra water for next season, the dry season. Aquifer depletion also can be studied, poor water use efficiency and then ever growing water demand. So, these are very critical aspects which can be studied efficiently managed efficiently to the help of ICT.

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ICT for efficient water management

- ICTs provides a unique opportunity for stakeholders involved in water management process, and helps them to obtain information about a number of physical and environmental factors.

- They also provide benefits in water management process such as:

- real-time monitoring and control at wide scale;
- integrated management and decision support based on data collection and aggregation;
- empowering user with real time information to create awareness and stimulate behavioral change;
- water smart meters and ICT tools to support leak detection and
- automated meter reading through communication networks.
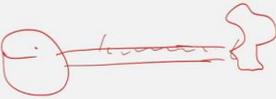
Because it provides a unique opportunity to the stakeholders whoever is involved in water management processes. Because ICT helps them to get the information about various physical, environmental, chemical, biological, all this information and ICT also provides benefits in water management processes like it provides real time monitoring and control at wide scale. You can actually capture at one point of time a very large area. Suppose I give an example in northeast Brahmaputra comes from very far away from China that side Tibet. And from there, then it enters into India and then it goes towards Bangladesh.

So, such a huge area now, information communication technology through remote sensing application of various other tools help you; allow you to capture or allow you to monitor in real time of that kind of huge scale.

Then comes integrated management and decision support based on data collections and aggregation.

It also empowers users with real time information, so that you can generate awareness among people about the resource crunch scarcity of water. Then it helps to develop water smart meters, an ICT tools can support any kind of leak detection, suppose you are supplying from this water tank through pipe far away somewhere in the village.

So, if there is any kind of leakage, ICT can also help you there are certain ways to do that, automatic meter reading through communication network. Now, these are certain smart technologies, which are already in few countries people are using it and they allow you actually real time monitoring of the water management system.

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Now mapping of water resources and weather forecasting is one of the much known uses of ICT and for that we have already discussed we use various kind of technology remote sensing based, GIS, sensor networks etc. Then asset management for the water distribution network very important aspect. So, here also ICT can help you to identify the appropriate manner in which you can actually maintain the assets which are required for water distribution network like smart

pipes; from 50 to 100 kilometre also sometime pipe can be connected from the source to the delivery point.

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Setting up early warning systems for meeting water demand suppose in one area, if you know that in dry season, there will be scarcity of water. So, you can have a contingency plan for that if you get that information well ahead of that particular dry season approaching in that area. So, these are various aspects for which you can get early warning through ICT.

In time crop irrigation, this is becoming very important these days. Days are gone when we used to start our pump and leave the field irrigated and farmers goes somewhere for some other activities maybe in other corner of the field and then come back and by that time so much of water gone somewhere else.

So, today it is important that you irrigate your crop exactly when it is needed. And for that we have already discussed in remote sensing some application of GIS information system, sensor base network, and internet. In fact, these days artificial intelligence machine learning also is being applied for coming out with some smart early warning system.

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1. Decision Support System (DSS)

- The complexity of water resources management and the difficulties of making decisions about the allocation of water resources are crucial. In such situations, decision support systems (DSS) are intended to assist to make strategic and rational decisions.

- Decision Support Systems is a specific class of computerized information systems that supports organizational decision-making activities. A properly designed DSS is an interactive software-based system intended to help decision makers compile useful information from raw data, documents and personal knowledge, to identify and solve problems and make decisions.

- A DSS helps structural decision-making processes and support the analysis of complex situations.

- Decision support systems bring together data and knowledge from different areas and sources to provide users with information beyond the usual reports and summaries. This is intended to help policy makers take informed decisions.

- A decision support system is an informational application as opposed to an operational application. Informational applications provide users with relevant information based on a variety of data sources to support better-informed decision-making. Operational applications, by contrast, record the details of business transactions, including the data required for the decision-support needs of a business.

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DSS decision support system. These are actually built or intended to assist to make strategic and rational decisions. Decision support system is a combination of various tool and a properly designed DSS could be very effective software based system which can help decision makers compiling various useful information from raw data, document them, store them, analyse them later identify the problem, and then finally make a decision. So, a decision support system helps the structural decision making process and it support the analysis of complex situations. So, these days DSS are very, important for you know, not only water management, but for entire natural resource management.
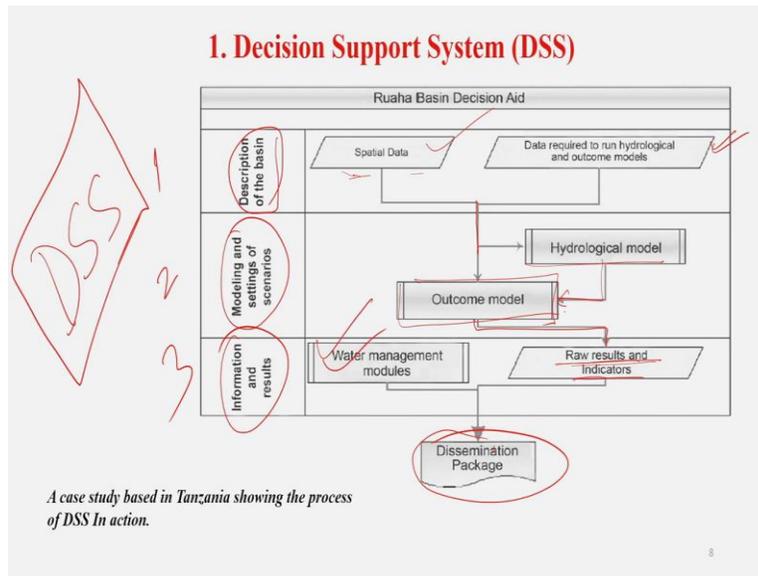
So, this is just an example that how decision support system functions. Decision support system will have description suppose of one area the basin description, then you can have modelling and settings of various scenarios. And then finally, information and results. These are the three main working platform.

So, the first thing is description of the area where you collect spatial data and then select the data which is needed to run hydrological model. Meansfrom these two the information you carry out in the hydrological model and from hydrological model then some information comes out here as outcome model and from outcome model you finally get raw results or some indicators. And these indicators basically with the help of various water management modules give you a decision package all together this system is called as decision support system. So, this is the simplest flow of decision support system which can work for water or also for soil or plant.

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GIS in watershed management. I think we have discussed it earlier quite a lot, but just to reinstate that, that ICT plays an important role in watershed management as well.

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To assess various watershed characteristics, what resources they have within a watershed, the quantity of the resources available, they need helps in management and planning of the watershed.

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Then, restoration of various resources, analysis of alternative management strategies, analysis of watershed policy and decision support finally.

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Now, the third one is you know, meters and sensors. Again, we have discussed about that in case of soil, meters and sensors can help you. But, these days again, a lot of sensors are used for specially avoiding any kind of damages in the water supply in a channel or pipe. Because that is one thing which we actually can avoid with the help of this technology. From 5 kilometre distance you are sending water to another village where they are actually dying out of water and

between the source and that village, the pipe if it leaks, then the precious water resources is lost and if you do not know or realise, hours together or days together, out of 100 percent probably 30 percent will reach there in the target village.

So, ICT can help you actually to find out the leakage of water in the transmitting challenges. So, with the help of different kinds of flow sensors, pressure management sensors, energy consumption sensors, supervisory control or data acquisitions, water quality sensors, water consumption meter, these are various you know small tools that actually helps to find out the leakage in the water transferring system or module.

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SCADA technology

SCADA systems perform main functions like the acquisition of data through the sensors, the transmission of the acquired data between a number of remote sites, the data presentation through the central host computer and the control of the data at the operator terminal or workstations. They can be can be incorporated into a system of hardware and software to improve the safety and efficiency of the operation of these large processes.

These systems usually consist of the following subsystems:

• Remote terminal units (RTUs) or programmable logic controllers (PLCs) which interface with the sensors in the process;

• A communication infrastructure connecting the remote terminal units with the supervisory system or central host computer;

• A supervisory (computer) system, gathering (acquiring) data on the process and sending commands (control) to the process, sometimes called a SCADA centre, master station, master terminal unit, or MTU;

• A communication system to support the use of operator workstations;

• Standard human machine interface (HMI) software or man machine interface (MMI) software system, which is used to provide the central host and operation terminal application of SCADA, support the communication system and monitor and control remotely located field data interfaces devices.

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So, in case of SCADA technologies, supervisory control or data acquisitions, there are various things are involved, especially just to give you an idea, you need a kind of a computation system, you need good quality of data and then processing then if your data quality is good, then certainly the analysis also will be good.

And finally, you can actually provide better solutions or better early warning information to the management team. So, sometimes the remote terminal units or programmable logic controllers like PLC's which interface with the sensor which actually sense if there is any kind of water leakage or water; then the information actually goes to the computer in the hub, where people are sitting to analyse those information. So, after all these all these technology helps you to maintain the water resources.

Hydraulic models, we talked about a little bit in modelling sections. Basically, it helps us to understand different hydrological processes and does the availability of water into the system and different organizations works with different models, different kinds of simulation, optimization products come out with a better water management system.

So, basically they look at how to minimize the water loss and how to increase the effective water management strategies. So, hydraulic models basically help water resource professionals or companies, universities, organizations, local bodies to effectively manage predict and make proper decision on the available water resources.

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5. Water supply, Irrigation design and management

• Utilizing different ICT tools to synchronize water supply with demand, regulate pump operations to save energy, manage the withdrawal of water from different sources and reservoirs, and control the purification processes in sewage recovery structures is one of the major water management goal.

• The different ICT tools applied in development activities helps to improve the network and hydraulic design of irrigation systems. Different elementary software applications were developed to calculate the water head losses during flowing water in pipes.

• New and advanced software applications simulate the water flow in a complicated loop of water network and facilitate optimization of pressure flow in irrigation systems. Designing of irrigation networks requires comprehensive software development using topography, aerial photography, and GIS data. This helps to facilitate computerized designs of irrigation network systems for a better water resource management.

• ICT tools help to facilitate computerized irrigation water budgeting system based on soil type and its water retention capacity, climatic condition, crop water requirements, soil moisture, and the plant water potential measurements. The designed water budget helps to programme solid scheduling of irrigation schemes.

• In addition, more advanced software also facilitates optimization of water distribution under the existing topography and the pressure regimes.

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Then comes water supply irrigation design and management another very important aspect. So, here also ICT tools can help actually to synchronize the water supply with demand. It can also regulate pump operation to save energy, managing withdrawal of water from different sources or reservoirs, control the purification process in sewage recovery structures. These are various activities, that again ICT can play a very important role in managing water resources.

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6. Urban water management

The very wide water domain and its stakeholder involvements cover an enormous number of all business domains and activities in the urban sector. Therefore, the development of ICTs focuses on five major areas that connect directly to the urban water supply and management activities:

1. Real time monitoring

2. Water efficiency

3. Energy efficiency

4. Asset management and field work management

5. Cities of tomorrow

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Urban water management, a very important you know, topic and all of you are aware of that managing water resources in a what you call sustainable manner in an urban ecosystem is a big

challenge for authorities, whoever is responsible for water management. So, here ICT can help you in real time monitoring, water efficiency, energy efficiency, asset management, fieldwork management, and also how that future cities actually should be built considering the best water management strategies in hand.

So, these are all planning that helps you to build smart cities, where you utilize every drop of water very carefully. And if you recall that in one of the earlier lectures, I mentioned about various types of new farming type also coming up in urban area people are now coming up with vertical farming in a building itself.

So, because the available land area, if you look at in any urban area is very less, almost 35 to 40 percent of the space that is available is on the building itself. So, that is why many countries are now coming with various new innovative kind of farming system, where water can be utilized in a very appropriate manner. So, ICT can also play a very important role.

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ICT application in water management: future aspects

There is ample potential for effective use of ICT in water management. However, much still remains to be done. Knowledge transfer should be two way considering the subject matter experts as well as the communities involved with the aim of building on their knowledge and capitalize it.

Thus information technology, jointly with communication sciences, can play a big role in blending different perspectives. Several future trends of great importance have emerged as:

1. Strong 'Network of Information System' for water and soil management at National, State and District Level
2. Pluralistic partnership between public, private, non-government organizations and water users and conservation association
3. Capacity building of different stakeholders in the areas of ICTs
4. Designing of different ICT based modules decision support system/expert system for water application methods, water conservation, water harvesting system etc.
5. Enhancing water use efficiency by using ICTs at field situation.
6. Pilot program for 'ICT enabled Soil and Water Management System' and its up scaling
7. Converging of media and tools for communication
8. Increased web based storage of relevant information;
9. Increased custom made, quality management information services etc.

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Now, its role in future strategy and planning for future smart cities or smart villages is enormous. So, several future trends of great importance can be actually handled by information communication technology, and it can play a big role in blending different perspectives. Now, if you look at a very strong network of information system for water and soil management, at national, state, and even district level is possible to establish with the help of ICT.

Then you look at pluralistic partnerships between public, private, non government organization, water users at the ground level, all of them can be brought together and can work for one single goal and they are also ICT can play an important role. Capacity building of different stakeholder, training, awareness, one person who is expert did not need to go to the village.

Today with the help of ICT, you can connect to the people to any part of the country or even outside the country. Designing of different ICT based modules, DSS decision support system, experts system for at water application methods is very much feasible today. Increasing water use efficiency is always a challenge in the field of agriculture. And ICT again can play an important role.

ICT enabled soil and water management system is a new branch actually, people are talking about that and some good work is already happening in the country, more needs to happen. Because the power of ICT must be utilized for managing resources critical resources like soil and water.

Increased web based storage of relevant information that we gather during this entire exercise with the help of ICT is another part which play very effectively. Increased custom made quality management information services et cetera can be provided generated provided with the help of ICT. So, you see that the future management system of resources like soil and water can be carried out quite efficiently with appropriate use of information communication technology.