

ICID NEWS

MANAGING WATER FOR SUSTAINABLE AGRICULTURE



MESSAGE FROM THE PRESIDENT

Dear Colleagues,

As the historic 2015 draws to a close, with the world leaders agreeing to work together on shared vision for a sustainable development, we are entering the year 2016 with great hope and expectations. Agenda 2030, supported by the willingness to act responsibly and containing the global warming, is likely to help eradicate poverty, hunger and malnutrition.

In line with the Sustainable Development Goals (SDGs) adopted by the UN General Assembly, ICID's Vision 2030 is for a "Water secure world free of poverty and hunger through sustainable rural development". It strives towards a development paradigm supported by sound agriculture water management practices with the goals of enabling the national committees (NCs) towards higher crop productivity; playing key role in changing the irrigation and drainage policies and practices; exchanging information, knowledge and technology; enabling cross disciplinary and inter-sectoral engagement; and promoting research towards extending innovation into field practices over the next 15 years. It represents our keenness to address broader water issues including water scarcity, water quality, environmental sustainability, integrated water resources management, etc.

ICID Vision 2030 has been an outcome of extensive deliberations and consultations with internal and external stakeholders and in that respect it presents the shared vision of the ICID fraternity and sets out the mission for the international network of irrigation and drainage professionals. It acknowledges the importance of creating an enabling environment, addressing the means of implementation and participation of local communities supported by international cooperation and capacity development.

ICID Vision 2030, presented to the 66th International Executive Council (IEC) meeting in Montpellier, 16 October 2015, received extraordinary support from the members and the Council called for drafting an Action Plan for achieving its goals. To put the Vision into action, NCs would be expected to proceed further in preparing implementation roadmaps in line with their national objectives and priorities. This will require the combined efforts of the Commission and require capacity development within the NCs at various levels.

Keeping these requirements in view, a Technical Support Unit (TSU) was approved by the Council to be set in ICID with the aim of undertaking capacity development activities in the field of agriculture water management. TSU will consist of distributed network of expert volunteers who commit to dedicate themselves to the TSU activities. NCs and partner institutions are expected to depute volunteer personnel for this purpose. Professional guidance and support will be made available to the NCs for initiating certain studies and activities to assist member countries in achieving the targets set under SDGs.

The 26th European Regional Conference with theme "Innovate to improve irrigation performance", along with the 66th IEC held in Montpellier, France, 11-16 October 2015 truly represented the path that ICID has chosen consciously over the years. The technical deliberation and exchange

of information at the Conference were extremely rich.

Outcomes of deliberations of some of the Workshops are shared in this edition of ICID NEWS. As can be seen, the conference provided an excellent platform to share multi-disciplinary tools that are being evolved, such as evaluation of ecosystem services, water footprint assessment, integrated flood management etc., for making the development through agriculture water management more sustainable. I would like to take this opportunity to sincerely thank the French National Committee on Irrigation and Drainage (AFEID) for hosting such a fabulous event.

The year 2016 will also witness our willingness to pursue further our goal of increasing stakeholders' involvement in decision making. I take this opportunity to invite all to the 2nd World Irrigation Forum (WIF2) scheduled for 6-12 November 2016 in the beautiful city of Chiang Mai, in Thailand. We will be devoting one section of ICID NEWS to present the views of various stakeholders. I invite you to make use of this opportunity and share your perspectives on "Role of irrigation in sustainable food production", theme of WIF2. To start with, in this edition, Dr. Bart Schultz, Chair of the International Technical Advisory Committee for WIF2, has presented an overview of the Forum.

Our utmost honor in ICID fraternity is to serve the society in relevant fields of its mandate coming up with a water secure world free of poverty and hunger by the year 2030.

Wishing you a very happy and fruitful 2016.

With regards,

Dr. Saeed Nairizi
President, ICID



Curtain Raiser to the 2nd World Irrigation Forum

Prof. Em. Bart Schultz*



With the adoption of Sustainable Development Goals (SDGs) by the UN General Assembly in September 2015; and the historic Paris Agreement reached at the United Nations Framework Convention on Climate Change Conference of Parties (COP21) in December 2015; it has been recognized that the new path for sustainable development will depend on poverty alleviation and food security through rural transformation, among others. Multi-faceted developments in this rapidly changing technology driven World will require substantial efforts from all of us to contribute to a sustainable future.

The triennial World Irrigation Forum (WIF) is one such effort being made through the International Commission on Irrigation and Drainage (ICID) that aims to bring together all the stakeholders involved in irrigation and drainage and allied sectors which alone can meet the growing food demand and address poverty, in times of changing climate and depleting freshwater resources and is key to the rural transformation. They include the policy makers, experts, researchers, consultants, manufacturers, contractors, academics and farmers through

various institutions, non-governmental organizations and development agencies. The Forum addresses the various multi-disciplinary perspectives that encompasses agriculture water management for rural transformation and includes irrigation, drainage, flood management, drought, land reclamation, climate and environment disciplines.

These stakeholders interested in seeking solutions to problems plaguing irrigated agriculture will be gathering at the 2nd World Irrigation Forum (WIF2) being organized by ICID and hosted by the Royal Irrigation Department from 12-16 November 2016 in Chiang Mai, Thailand. Threads will be picked up from the outcomes of the successful organization of the 1st World Irrigation Forum (WIF1), in Mardin, Turkey, in October 2013 (http://www.icid.org/conf_wif1.html).

Actions roadmap as committed and deliberated at the 7th World Water Forum held in South Korea, in April 2015 which have shown that upgrading, modernisation and expansion of irrigation, drainage and flood management schemes are among the key issues to assure sufficient and sustainable food production for an ever growing and more prosperous World population. Irrigation and drainage has to play an important role in improving the living conditions, primarily in the rural area, as well as in drought and flood prone areas. Last but not least, irrigation and drainage are essential to encounter the expected changes and increases in climate variability and the impacts of man-induced changes in land use. Within this framework



the Main Theme chosen for WIF2 is:

Water management in a changing world: Role of irrigation for sustainable food production.

Various relevant issues and new developments in irrigation and drainage for sustainable food production will be presented and discussed under three Sub-themes as agreed to by an International Technical Advisory Committee (ITAC):

Sub-theme 1: Key issues of irrigation and drainage in balancing water, food, energy and ecology

Sub-theme 2: Management of climatic extremes with focus on floods and droughts

Sub-theme 3: Key and smart actions to alleviate hunger and poverty through irrigation and drainage

Discussions on the Theme and Sub-themes will be based on the Background papers prepared by eminent international experts, Keynotes delivered at the Forum by prominent experts, submitted papers and short communication by experts. Multi-disciplinary perspectives will be presented through roundtable discussions, side events and an exhibition showcasing the contribution from private sector, various international and regional and national organizations to the cause of irrigation and drainage.

While it is a Forum, a substantial part of the sessions will be devoted to the discussions and formulation of hopefully shared visions and recommendations for future directions. Water resources/ Agriculture Ministers from prominent countries around the world, practicing irrigated agriculture are expected to gather and have a roundtable to deliberate on the way forward to rural transformation through irrigated agriculture, addressing the need for a mechanism to support countries in meeting the Targets and Indicators being set under the umbrella of United Nations statistics division for monitoring the relevant SDGs.

WIF2 offers splendid opportunities to present new developments, research findings or products to an international audience representing all stakeholders from the sector. WIF2 is the largest business event relating to agriculture, water, and the environment that will provide a special opportunity for corporates to show case



* President Hon., ICID and Chairman, International Technical Activities Committee (ITAC)

their products and services. The Forum also enables participants to get information on latest developments in the field of irrigation and drainage from all over the World.

You are invited to prepare your papers or short communications, which starts with the preparation and submission of an extended abstract. The papers will primarily have to deal with new developments on the Sub-themes and the topics associated with them. Short communications will provide you the opportunity to describe new products, equipment, software, models, information systems, etc.

WIF2 online papers submission process has started, extended abstracts of the papers can now be uploaded online using URL: [https://www.easychair.org/](https://www.easychair.org/conferences/?conf=fwif2016)

[conferences/?conf=fwif2016](https://www.easychair.org/conferences/?conf=fwif2016) for review of an international panel of experts. ICID looks forward with great interest to receive your contributions and participation.

For this Forum, the beautiful city of Chiang Mai, located in the heart of irrigation areas in Thailand, has been selected as it offers excellent facilities for a very interesting and agreeable participation (www.worldirrigationforum.net). The host city not only offers excellent facilities for a good conduct of the Forum, but also offers excellent opportunities for technical tours, study tours and a wide variety of cultural and touristic trips. As hosts, Thailand National ICID Committee (THAICID) will make all possible arrangements for the success of the WIF2. As the largest

exporter of rice in the World, rated as popular tourist country, and located in the Asian Continent with excellent international connections, Thailand has a lot to offer.

ICID sincerely hopes that WIF2 in Chiang Mai will result in a substantial contribution to sufficient and sustainable food production, reduction of under nourishment and improved living and production conditions, primarily in the rural areas. Up-to-date information on WIF2 can be found on the following websites: <http://www.worldirrigationforum.net> and http://www.icid.org/conf_wif.html.

As Chairman of the ITAC, I look forward for your active participation and would like to see you all in Chiang Mai. ✦

Water footprint as a policy tool and its standardization

Dr. Young Deuk Kim*

Water is fundamental to agricultural production, and thus supports not only the livelihood of rural community, but also supplies food, fiber, energy and environmental benefits to the global economy. Freshwater, though renewable, is a finite resource very much like fossil fuel and minerals. However, the increasing demand for water in almost all sectors of economy in most developing economies the increasing variability of water resources due to climate change is bringing the resources under stress generating conflicts among different sectors, regions and users.

There is an increasing understanding of the risks associated with the world's freshwater resources. As a result, there has been a radical increase in media, public and business recognition of the importance of water from social, economic and ecological perspectives. More progressive governments have begun to reform water policies and reassess their water-related priorities, in wider consultations with all the stakeholders and civil society and multinational companies have begun to assess the risks and uncertainties they face throughout their operations and supply chains.

Water is becoming everybody's business and there is greater need for communication with non-technical players. Recently, there have been many attempts to seek a way for efficient use of water to relieve the stress using indicators and analytical tools. One of the attempts is to use Water Footprint (WFP) and inclusion of water use in Life Cycle Assessment (LCA).

Water footprint is an indicator of freshwater use that looks at direct and indirect water use of a consumer or producer. Water footprint of a product is the volume of freshwater used to produce the product, measured over the full supply chain or life cycle. It can provide extended views on the way how we use water: what type of water we use, and when and where we use it. It is a multi-dimensional indicator, showing water consumption volumes by sources and polluted volumes by types of pollution.

By itself, the water footprint does not solve complicated water management challenges, but it can be applied, to support awareness and policy development and contribute to positive actions. Water footprint started to be spotlighted at World Water Forum (WWF4) in 2006 since the introduction of virtual water concept by Allan (1993 and 1994) and Water footprint by Hoekstra and Hung (2002). It has evolved from basic quantitative studies to a powerful advocacy tool, and has the potential to provide relevant policy support, business risk awareness and decision-making and an assessment tool for policy processes.

Water footprint can be used for seeking options for reduction of water use and increasing water use efficiency at production stage for farmer, and for reduction of water consumption in their own operations and bringing down water pollution. Furthermore, it can help in implementation of good water policy for



wise water governance at national, river basin and local level.

International Organization for Standardization (ISO) started standardization of water footprint from 2009 and released the ISO 14046:2014 (Environmental management - Water footprint - Principles, requirements and guidelines - <https://www.iso.org/obp/ui/#iso:std:43263:en>). Currently, new standard documentation (ISO/TR/WD4 14073) is on the way to supply illustrative examples on how to apply ISO 14046.

Water footprint standards can contribute to water resources protection and improvement of water use efficiency. Figure demonstrates the Water footprint assessment phase. Detailed procedure and methodology can be refer ISO 14046 document. These documents on water footprint may contribute to assess water footprint in supply chain and facilitate

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efficiency and optimization of water management at product/service level with provision of detailed information and a communication window to interested parties. In response to the international standardization, many countries including Korea are striving to meet the requirement and to adopt water footprint in the water resources management scheme.

It is expected that water footprint application in water management and agriculture will be widespread according to the standardization.

There are a number of issues that need to be tackled for application of WFP of product or service through standard document releases. Further study is desirable to reflect regional characteristics of water footprint data to minimize uncertainty of the inventory data. Secondly, it is necessary to narrow down the gap of geographical resolution between the inventory and regionalized WFP. It is significant to consider temporal and regional variations of water footprint

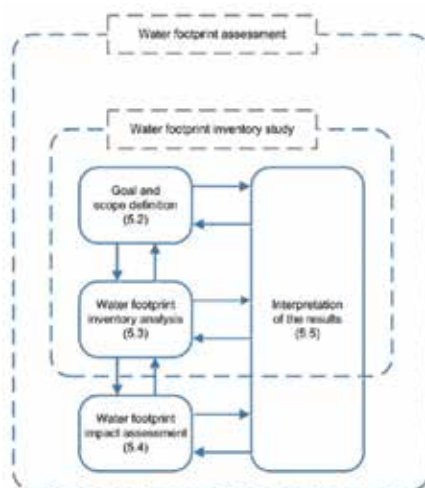


Figure. Phase of water footprint assessment (ISO14046, 2014)

inventories. Particularly in agricultural sector, the distinction between the irrigated and the non-irrigated crop in the water footprint inventory is necessary in the refinement of the water footprint data.

As water footprints evolved, there have been links to water management decision-making, yet to date the role of water footprint methods in water policy is limited to a few river basins. Work in Spain around the Guadiana basin has resulted in an economic assessment of water footprints that have now been captured as part of the Water Framework Directive assessments in that country. The interest and relevance of water footprint assessments of economic activities in basins, may lead to explicit policy making at national levels with regard to the use of water resources especially for higher value uses.

In the business world, the water footprint concept has helped to shed light on business water-related risk. It is perhaps through this lens that the water footprint is beginning to influence business strategies, which, in turn, may come to bear in formulating water policy that is coherent and consistent for business sectors.



Report on the International Workshop on 'Ecosystem Services and Multi-Functionality of Irrigation and Drainage Systems'

Dr. Sylvain-Roger Perret*



The International Workshop, on 'Ecosystem Services and Multi-Functionality of Irrigation and Drainage Systems', organized by ICID's Working Group on Environment (WG-ENV), on 13 October, 2015, Montpellier, France provided a rare opportunity to investigate the relationships between society and irrigation and drainage systems, beyond the mere provision of food and fiber goods.

The scoping keynote address by Dr Damien Jourdain (France), provided

broad perspectives on definitions, possible approaches to valuation, and remaining issues and challenges. He took the participants through a most valuable trip into the complexity of natural resource economics. A summary of his presentation is available at page 5. For non-economists and irrigation practitioners, what is important to keep in mind that a classification of ES by irrigation systems does exist, and tools do exist to value those services. This was illustrated by Dr. Jourdain through an extremely illustrative and explanatory case study with the use of choice experiment in Thailand.

Dr Jourdain highlighted the issues in ES assessment and valuation: hierarchy (why an ES be 'better' or more commendable than another) and substitutability (can the loss of a given ES be compensated by gaining another) that remain to be resolved.

Other presentations illustrated the use of the multiple methods available (replacement cost approach contingent valuation method, cost avoidance approach, analytic hierarchy process, choice experiment, etc.) in selected case studies, with a relative

focus on paddy rice systems, and also on watershed applications.

Discussions were rich and lively raising key questions and ideas on the use and follow-ups to ES valuation (information, awareness and education, policy justification, compensation for good practices); discussion also stated that ES valuation may prove viewpoint dependent (depending on method and initial hypotheses, on its motivation). Rice and paddy fields were definitely identified as challenging, multifaceted, multi-scale situations, with lots of interactions with ecosystems and society.

As a conclusion, the workshop highlighted the many interests and possible applications of ES valuation, from the case studies presented: (i) Ex post justification for heavy subsidizing agriculture (France, Thailand, Korea); (ii) Fair compensation for ES related losses by farmers (Flood control); (iii) Educational value, vehicle for collective action and deliberation, participation, awareness; and (iv) Cost allocation amongst water users and ESS beneficiaries.



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Value of Ecosystem Services provided by Irrigated Agriculture

Dr. Jourdain Damien¹ and Dr. Sylvie Morardet²

It is now recognized that irrigated agriculture is producing more than just food products. Irrigated fields are part of agro-ecosystems defined here as the combination of a territory and a mix of productions (both crop and animal productions) and management practices and perform many different functions that are of use to humans that can be broadly defined as ecosystem services. These services include regulatory functions: carbon sequestration, support for biodiversity, groundwater recharge; and/ or socio-cultural functions: landscape, cultural values etc. However, agriculture may as well produce negative impacts on the ecosystems as they depend upon increased pollution, depletion of water resources elsewhere, ultimately rendering dis-services to other categories of the population.

Both types of services are usually poorly taken into account by decision makers (from farmers to policy-makers), because they are difficult to measure both physically and economically and are rarely traded on markets. Measurement of the economic value of ecosystem services produced or destroyed by irrigated agriculture would help decision-makers design policies that provide farmers with incentives to produce a more balanced set of services.

Designing policies accounting for the ecosystem services provided by agriculture is a complex task. A purely economic approach would look for a policy that maximizes the total economic value (TEV) generated by the agro-ecosystems in which all services, traded on market or not, are economically valued. However, policy makers may also be interested to identify who are the beneficiaries of the various services of irrigated agro-ecosystems.

Two types of challenges generally found when attempting to use ecosystem services values for improving agricultural, land and water policies. The first one pertains to the difficulty to give an economic value to services that are not exchanged on markets. The second one pertains to potential pitfalls when using those economic values to design new policies.

The value of market goods can be easily inferred since the demand function reveals consumers preferences for the different goods. The value of non-market goods are calculated using the people's willingness-to-pay (WTP) for positive services, and their willingness-to-accept (WTA) compensation

for negative services using different economic valuation techniques based on revealed or stated preference elicitation methods (such as travel cost method or hedonic pricing methods for the former, and contingent valuation or discrete choice modeling for the latter). The selection of the method will depend on the type of services to be measured (e.g. the travel cost method is more appropriate for use values of recreational resources), the type of data available, and the type of value to be estimated (e.g. use or non-use values).

Using stated preference techniques which makes aggregation of ESs to a regional or national level difficult, as it is important to recognize that they are built upon strong behavioral assumptions that:

- (a) people are able and ready to substitute one service with other services, and ecosystem services with money (less of one service can be compensated by the increase of another service, or by monetary compensation);
- (b) people have a good knowledge of the services to be valued;
- (c) respondents may have a strategic interest in overstating their willingness to pay for services; and
- (d) there is known scale effect when asking people their WTP for a service (i.e. if they are WTP a certain amount for a given protected area, they would not pay double for the double of that area).

When designing policies taking into account the value of non-marketed ecosystem services co-produced by irrigated agriculture, there are still some important challenges.

First, agro-ecosystems are producing different mix of ecosystem services and dis-services, depending on their location and the objectives pursued by farmers. One can observe different forms of associations between ecosystem services: most often, the provision of one specific service is developed at the expenses of other services (e.g., increasing food production in a territory has often been associated with decreases in biodiversity and to an increase in pollution). In these cases, there are important trade-offs among competing ecosystem services, that may vary spatially. However, in other cases,

synergies occur between two or more services that are jointly provided by irrigated agro-ecosystems (e.g. attractive agricultural landscape and food production).

Second, while the economic valuation exercise give an economic value to a service (independently of the method to obtain it), the policy makers also need to know what type of services would be supplied by the same ecosystems under different management scenarios. The evaluation of the ecosystems as a stock of resources does not suffice, since the same stock of resources arranged differently would produce entirely different services (think about a car before or after an accident: they have the same stock of resource but one can complete a function that the broken car cannot anymore). Since we are interested in the functions and not the stock, some important effort is needed to understand the relationships between ecosystems configuration (including agricultural ones) and service production.

Third, a possible pitfall would be to consider that a service is only provided by irrigated agriculture while, in fact, it could be obtained through different land uses. For example, rice fields are recharging aquifers or can be used as expansion areas to mitigate flood damages; however, other natural land uses (e.g., wetlands) can fulfil the same function while providing additional desired environmental services (increased biodiversity). Paying per hectare fees to rice farmers because they recharge the aquifers would increase incentives to grow rice in areas that would be better used as natural wetlands.

To conclude, assessing the values of non-marketed ecosystem services supplied by agriculture is an important policy challenge for promoting an irrigated agriculture that provides the right balance of food products and other environmental services. This short review shows there are still many challenges both for measuring demand for various ecosystem services, and integrating demand functions into a coherent policy framework.

Presentations can be accessed from: (i) http://wg-env.icidonline.org/env_2015_jourdain.pdf; and (ii) http://wg-env.icidonline.org/env_2015_morardet.pdf

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Report on the Training Workshop Integrated Flood Management: From Theory to Practise

Dr. Giacomo Teruggi, Ms. Sara Oppenheimer and Ms. Maud Poissonnier - Lescuras



Associated Program on Flood Management (APFM) under the World Meteorological Organization (WMO) has developed an approach to flood management that improves the functioning of the river basin as a whole, recognizing that floods have beneficial impacts and can never be fully controlled. Integrated Flood Management (IFM) approach seeks to maximize the net benefits from the use of floodplains and to minimize loss of life.

IFM is defined as a process that promotes an integrated, rather than fragmented, approach to flood management. It integrates land and water resources development in a river basin, within the context of Integrated Water Resources Management (IWRM). The Concept Paper on IFM developed based on wide consultations with various specialised agencies engaged in the flood management activities describes the principles, objectives and aspects of IFM in detail.

IFM approach has the potential to address the challenges that are being faced by the countries, communities, catchment areas around the world due to flood risks. These are:

- (a) Increased population and enhanced economic activities in floodplains further increase the risk of flooding;
- (b) Intensity and duration of precipitation events are likely to increase due to climate change, resulting in an increase of the frequency of major floods in many regions;
- (c) Population growth and economic growth exert considerable pressure on the natural resources system;
- (d) Riverine aquatic ecosystems provide such benefits as clean drinking water, food, materials, water purification, flood mitigation and recreational opportunities; and
- (e) The magnitude and variability of the flow regime needed within a basin to maximize the benefits to society and to maintain a healthy riverine ecosystem must strike a balance between competing interests in the river basin.

The APFM, hosted by the WMO was invited to the 26th European Regional Conference in Montpellier, France, October 2015, to conduct a training workshop on “**Integrated Flood Management: From theory to practice**” for thirteen young professionals coming from different countries. The objective of this training was to introduce the concept of Integrated Flood Management (IFM) to the Young Professionals.

The workshop was organized to familiarize participants with the concept of IFM. Dr. Giacomo Teruggi, Ms. Sara Oppenheimer and Ms. Maud Poissonnier - Lescuras from APFM, under WMO, introduced the concept of IFM to the participants. The gist of the concepts covered under the training are presented in this article.

Speaking during interaction with the participants, Secretary General Avinash C. Tyagi appreciated the efforts by the APFM team and hoped that understanding of the main principles of IFM, with the social, environmental, economic, legal and institutional dimensions presents a comprehensive approach. It is hoped that the ICID Working Group on Comprehensive Approaches to Flood Management (WG-CAFM) will adequately incorporate these concepts in its deliberations and outcome.

Expressing his appreciation for the training, ICID’s President Dr. Saeed Nairizi wished for further cooperation between the APFM and ICID to support developing countries on issues related to irrigation, water, weather and climate and thanked WMO for the financial support provided for the participation of Young Professionals from developing countries to this training.



The Concept Paper is supported by a number of papers in a Policy Series that focuses on various aspects of flood management policy: economic, environmental, legal and institutional, and social aspects. The participants were also introduced to the case studies on flood management collected from various regions, based on the experiences of organizations active in flood management.

The concept of IFM is recognized and is supported by a “Support Base Partners” that include: UN Organizations, International Organizations, Civil Society Organizations, Research Organizations, and specialized national institutions involved in the flood management activities. IFM has been universally accepted by the United Nations network on Water the UN-Water. The UN-Water Policy Brief on “Climate Change Adaptations: Pivotal Role of Water” recognizes approaches – such as IFM as robust and adaptive to manage floods.

The workshop provided examples of practical applications and tools that are available through the IFM HelpDesk for application of the IFM concept in different socio-economic environments. The Flood Management Tool Series that has a collection of tools for flood management practitioners provide quick access to relevant technical guidance on specific issues was introduced. Training Manuals, developed as a basis for training courses on specific aspects of IFM (e.g. urban flood

management and adaptation to climate change) were also informed.

HelpDesk for Integrated Flood Management (IFM) is a facility that has been established by APFM to provide guidance on flood management policy, strategy, and institutional development for countries willing to adopt the IFM concept.

The HelpDesk provides support through the ‘Get Help’ function and/or through the ‘Help Yourself’ section. Rapid guidance function provides a way to the help seeker to get in touch with the Technical Support Unit established by WMO under APFM and obtain guidance to the right combination of materials and information from various sources available, including the possibility to consult the Support Base Partners.

With the assistance of WMO, APFM organizes training courses in countries. Being demand-driven and individually tailored to the needs of the requesting parties, their scope, duration and topics vary, but can generally be divided into the following: vocational workshops to mainstream and promote the concept of IFM; workshops analysing the current flood management situation and developing a national IFM strategy; training of trainers workshops to build capacities at the local level and create a network of practitioners familiar with the concept of IFM.



Drainage Pipes for Land Reclamation

Drainage pipes are used to drain excess water present in the soil. Whether it is construction or agricultural investment; one of the main components for engineers/planners is to deal with the drainage problems, which requires significant amount of investment to remain operational for long term.

The first plastic pipe in the world was manufactured in 1962. Till date, manufacturers guarantee only pipe's underground strength and life cycle, excluding guarantees of continued function of the drainage pipes underground. However, it is more important that drainage pipe must keep on performing during its underground life cycle. In addition to iron oxide and calcium carbonate, other factors like bacteria, silt or plant roots clogging problems affect the pipe performance. Therefore, periodic maintenance or laying new drainage pipe lines in the fields has been required since now.

In order to increase water flow and prevent clogging problems worldwide, organic, mineral and synthetic type of envelope materials are being used on drainage pipes in order to save the investment and have long life (underground). In this regard, Gravel & Sand Envelope materials, Geo-textile Envelope Materials, French Drain

(Gravel & Sand plus Geo-textile envelopes) are available in the market. The efforts of all such filter systems are to overcome the clogging issue. However, a hundred percent success rate could not be achieved with any one of these technologies. The most important research works on these issues were being done by United State Bureau of Reclamation (USB), McGill University, International Institute of Land Reclamation and Improvement (ILRI), and Wageningen University. While going through their reports, it was noticed that clogging problems are one of the most discussed topics of the 21st Century. ICID and FAO recognizes these important issues and prioritized the need for effective management. This issue was also supported by the World Bank in land reclamation projects worldwide.

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Hydroluis displayed their products during the 66th IEC meeting and 26th ERC, Montpellier, France, October 2015 and was widely appreciated by the members and participants.

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Crop Rotation: An Approach to Save Irrigation Water under Water Scarcity in Egypt

Prof. Samiha Ouda¹ and Prof. Abd El-Hafeez Zohry²

The WatSave Innovative Water Management Award 2015 was awarded to Prof. Samiha Ouda and Prof. Abd-El-Hafeez-Zohry (Egypt) for their research work on "Crop Rotation: An Approach to Save Irrigation Water under Water Scarcity in Egypt". This article provides the glimpses of their work on investigating the water use efficiency by crop rotation.

A major tenet of sustainable agriculture is to create and maintain diversity. Intercropping and crop rotation have been practiced for hundreds of years, perhaps centuries, as they offer farmers the opportunity to engage nature's principle of diversity in their farm management practices. Pest management, nutrient management benefits can be realized from intercropping and crop rotation practices due to increased diversity as the crops growing together in the mixture complement one another. Intercropping productivity has been assessed based on the Land Equivalency Ratio. However, little efforts have been made in the past on the assessment of water saving due to crop rotation and intercropping.

Crop rotation is an agricultural management practice that could save on the applied irrigation water. This practice is one of the most effective agricultural control strategies. It involves arrangement of crops planted on the same field; and the succeeding crops should belong to different family. Using crop rotations in Egypt has helped in the sustainable use of natural agricultural resources; increase the agricultural productivity of unit land and unit of irrigation water under the prevailing conditions of water scarcity. As a result, the probability of attaining food security for strategic crops will increase and will help in improving standard of living and poverty elevation of rural population.

Intercropping is another approach to save on the applied irrigation water when implemented inside the crop rotation. It is a successful avenue to increase the cropped area without altering the area cultivated by the main crops in winter or summer. Using intercropping method, by growing two or

more crops in the same field, allows using water and nutrients more efficiently. The team calculated water requirements for a prevailing crop rotation in an old field, with soil specifications - salt affected, calcareous, and sandy, in addition to sugarcane rotation in South Egypt and suggested water saving rotations, systematically calculated its water requirements and achieved saving in irrigation water.

The prevailing crop rotation in the old farm land is characterized by cultivating, crops on rows or in basins, in which a large amount of irrigation water is applied and cultivating crops that cause soil exhaustion. The proposed rotation is characterized by cultivation on raised beds to save 20% of the applied irrigation water and increase productivity by 15%. It also contains crops that maintain soil fertility through cultivating cereal crops followed by legume crops.

Furthermore, mono crops are replaced by intercropping to save on the applied irrigation water. For example, cotton relay intercropped with wheat, which increases wheat cultivated area by the area assigned to be cultivated by cotton and save the first two irrigations; cotton; maize intercropped with soybean will increase the land and water productivity; faba beans intercropped with sugar beet to reduce its production-consumption gap, as well as increase land and water productivity because no extra irrigation water or fertilizer is applied to faba beans; and cowpea intercropped with maize to increase maize yield and reduced associated weeds with no additional irrigation water. The saved irrigation water amounts to around 1095, 1331 and 1546 m³/ha in Lower, Middle and Upper Egypt, respectively.

The prevailing rotation in salt affected soil is characterized by intensive rice cultivation to leach salts away from root zone. However, rice cultivation after wheat and rice cultivation after sugar beet are exhausting to the soil. Thus, in the proposed rotation, short season clover was planted after summer crop and before winter crop to improve soil fertility. Through this rotation a saving of 3426 m³/ha was achieved.



Maize intercropped with tomato

In calcareous soil, around 3160 m³/ha could be saved, if the proposed rotation is implemented. This amount was a result of cultivation on raised beds and intercropping maize with tomato, as well as faba beans with sugar beet.

The proposed rotation in sandy soil could be used with sunflower intercropped with soybean; and sesame intercropped with peanut, which saved all the applied water to sunflower and sesame. As a result of using sprinkler and drip systems in sandy soil, the saved water amount was low, i.e. 53, 67 and 152 m³/ha in Lower, Middle and Upper Egypt, respectively. This low amount is a result of replacing maize with sunflower when it is intercropped with soybean, where sunflower has lower water requirement than maize.

The saved amount of irrigation water under proposed sugarcane rotations was 3596 and 7609 m³/ha for spring and autumn rotations, respectively. This saving is a result of intercropping winter crops (faba bean and onion) on autumn sugarcane and summer crops (sesame, soybean and sunflower) on spring sugarcane.

Thus, implementing crop rotation and intercropping has helped in achieving food security in Egypt through increasing land productivity. Furthermore, it can save a sum of irrigation water and increase water productivity in the region. These saved irrigation water amounts can also be used to cultivate new areas and reduce the food gap.

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