Summary of Proceedings

Conference on:
The Use of Treated Wastewater in the Agricultural Production in the Arab World: Current Status and Future Prospective

14-16 January 2014
Dubai, United Arab Emirates

Prepared by:
International Center for Biosaline Agriculture (ICBA)

Organizers

وزارة البيئة والمياه
MINISTRY OF ENVIRONMENT & WATER

United Arab Emirates Ministry of Environment and Water
www.moew.gov.ae

International Center for Biosaline Agriculture
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Strategic Partners

Arab Center for the Studies of Arid Zones and Dry Lands
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Environment Agency - Abu Dhabi
www.ead.ae

Islamic Development Bank
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ACRONYMS

ACSAD	Arab Center for the Study of Arid Zones and Dry Lands
CC	Climate Change
FAO	Food and Agriculture Organization
GCC	Gulf Cooperation Council
ICBA	International Center for Biosaline Agriculture
IWMI	International Water Management Institute
ICARDA	International Center for Agricultural Research in the Dry Areas
MENA	Middle East and North Africa
MOEW	Ministry of Environment and Water
TWW	Treated Waste Water
IPCC	Intergovernmental Panel on Climate Change
WB	World Bank
WHO	World Health Organization
WG	Working Group
WW	Waste Water

FOREWORD

With only 1.3% of world's renewable fresh water, the MENA region is the most water scarce region of the world. Ninety percent of the land is located in dry and semi-dry areas. In addition to water scarcity, population increase, economic growth, improvement of living standards, industrialization and tourism have added more pressure on water resources and their use. Scarcity of water resources is further aggravated by the impact of climate change, particularly the evident decrease in rainfall and increase in temperature.

Exploring new unconventional water resources such as treated wastewater (TWW) is becoming increasingly important in the region. With increases in population the amount of wastewater and the number of wastewater treatment plants has increased in most of the Arab countries with conservative estimates from FAO indicating that there is around 10.9 billion cubic meters per year. Only 50% of the available treated wastewater is actually being used for agriculture, landscaping, industrial and environmental purposes.

Here at the International Center for Biosaline Agriculture (ICBA) we consider that treated wastewater, if used safely, is a valuable source in the region's water balance. Using TWW can contribute to enhancing the productivity and income of farmers in the region. Recognizing this ICBA, in collaboration with the Arab Center for the Study of Arid Zones and Dry Lands (ACSAD), the Islamic Development Bank (IDB) and other donors, have been conducting research studies, capacity building programs, expert meetings and workshops in the Arab region over the past five years. In 2010 a regional project on the "Safe use of treated wastewater in agriculture in the Arab world" was implemented in three countries, Jordan, Oman and Tunisia, representing the diversity of treatment methods and use in various agricultural production systems. Extensive information and data have been produced and many lessons have been highlighted.

Under the patronage of His Highness Sheikh Hamdan bin Rashid Al Maktoum, Deputy Ruler of Dubai and Minister of Finance, the UAE Ministry of Environment and Water (MOEW), ICBA and ACSAD organized the conference on **"The Use of Treated Wastewater in the agricultural production in the Arab World: Current status and future prospective"** from 14-16 January 2014 in Dubai, United Arab Emirates.

This report bears testimony to our collective efforts to better understand the challenges and opportunities of TWW as a non conventional source of water. We hope that this effort will help in identifying priority areas, bottlenecks and solutions associated with the use of TWW in the Arab world and in strengthening regional cooperation and joint efforts towards the realization of the full potential of the TWW in supporting agricultural production, food security and livelihood of the farmers in the whole region.

Dr. Ismahane Elouafi
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ACKNOWLEDGMENTS

ICBA would like to sincerely thank His Highness Sheikh Hamdan bin Rashid Al Maktoum, Deputy Ruler of Dubai and Minister of Finance for his patronage of the Conference. Also, ICBA express its appreciation and gratitude to His Excellency Dr Rashid Ahmed bin Fahad, the Minister of Environment and Water for his support to the success of the conference.

ICBA acknowledges the valuable contribution and support provided by our key organizing partners, the Ministry of Environment and Water and ACSAD. A note of appreciation goes to the international organizations that cooperated and supported the Conference.

The staff from ICBA and the Ministry was instrumental in the planning and organizing of the conference. The contribution of members of the scientific and organizing Committees is greatly appreciated. Our appreciations and acknowledgments go to Mrs. Seta Tutundjian, the writer of this summary report.

Last, but not least, thanks to all the scientists and partners for their invaluable contributions and technical summaries that made it possible for the conference to be such an informative and successful event.

EXECUTIVE SUMMARY

This report provides a brief summary of the proceedings and recommendations of the "Use of Treated Wastewater in Agricultural Production in the Arab World: Current Status and Future Prospective" conference, held in Dubai during January 2014 under the patronage of H. H. Sheikh Hamdan Bin Rashid Al Maktoum, Deputy Ruler of Dubai and Minister of Finance.

During the conference 120 experts from the Arab region together with leading international experts shared global, regional and local experiences and lessons learned regarding the use of wastewater (WW) and treated wastewater (TWW) for agricultural production. Participants were divided in three Working Groups (WGs) that discussed: current knowledge, gaps and future directions in the use of TWW in agricultural production; regulations and strategic planning; and, existing partnerships, regional cooperation and future opportunities. They identified the existing gaps and key future needs. The findings and recommendations presented in this summary report are based on the presentations and discussions during the conference and should be seen as a starting point for needed future interventions to further promote and expand the use of WW and TWW not only in the Middle East and North Africa (MENA) region, but globally.

Although indirect WW reuse has been going on throughout history, the past few decades witnessed the spread of formal and planned WW and TWW reuse for agricultural production. This growing trend of planned reuse enables governments and stakeholders to mitigate the environmental and health hazards associated with the reuse of WW. The MENA region includes many countries reusing both WW and TWW for agricultural production, and the trend is expanding with TWW now included in the water budget of several Arab countries.

Public perceptions towards TWW reuse, and farmers concerns and unwillingness to switch from irrigating with "free" fresh groundwater resources were cited as key challenges that need to be addressed. Lack of knowledge about the risks, and lack of trust in authorities were identified as main reasons contributing to the resistance of farmers and the public. Nevertheless, experience in many Arab countries demonstrated that severe water scarcity greatly facilitates farmers' acceptance and usage of TWW and even WW.

As water becomes scarcer in the Arab region, reuse of WW will no longer be an option but a necessity, accordingly there is a need to: examine the benefits and costs of WW reuse and build future expansion programs based on the results of these socio-economic-health analysis; develop comprehensive management practices and tools for irrigation with WW and TWW to minimize risk and hazards; establish national and regional TWW reuse monitoring systems; develop national and regional laws, regulations and standards pertaining to TWW reuse. Concurrently, there is a need to establish accountable institutes within the countries of the region that are responsible for monitoring and enforcement to ensure the highest standards of health and safety. Additionally, there is a need for a regional platform that leads these efforts and acts as a facilitator that brings together institutions and experts to share results, information, lessons learned, and best practices.

INTRODUCTION

Water can be classified as the single most critical natural resource; for water is a basic human need, without which there is no life!

Today, the world is facing an ever-growing fresh water scarcity! With the steady growth in the global population, changes in living standards and dietary preferences, coupled with the accelerating climate change (CC), experts predict that water shortages will exacerbate in the coming years and decades. This will have dire impacts on agriculture and world food supply, public health, economic development, energy generation and the sustenance of many.

Across the globe, ground water resources are being depleted at an unprecedented rate, which is negatively impacting the quality of the groundwater as it becomes more saline and polluted which is negatively impacting the environment.

By 2050, the world population is expected to hit 9 billion. Most urban cities will expand and require more fresh water resources to meet their basic human and public health needs, plus their demand for water-intensive energy will also double. Demand for food, the world's largest water user, will grow drastically, requiring even more water.

The extreme weather conditions that we have been witnessing in recent years due to the Earth's changing climate will worsen. Droughts, floods, major storms will increase in severity and result in an increasing water stress. Experts estimate that by 2080, 43 to 50 percent of the global population will be living in water-scarce countries, compared to 28 percent today. A new World Bank report suggests that in a 4°Celsius warmer world, water stress will increase in areas around the world. The roughly 1 billion people living in monsoonal basins and the 500 million people living in deltas are especially vulnerable[1].

The Middle East and North Africa (MENA) region is already facing severe water scarcity with seven Arab countries included in the top 10 water scarce countries globally. According to the UN Intergovernmental Panel on Climate Change (IPCC, 2001, 2007 and 2013 reports) assessment, in the coming years, this scarcity is expected to increase further as the MENA region becomes hotter and drier. Drought will be an increasing phenomenon, posing more pressure on already depleted groundwater resources and putting an additional burden on the agricultural sector that is already competing for its water with municipal and industrial uses.

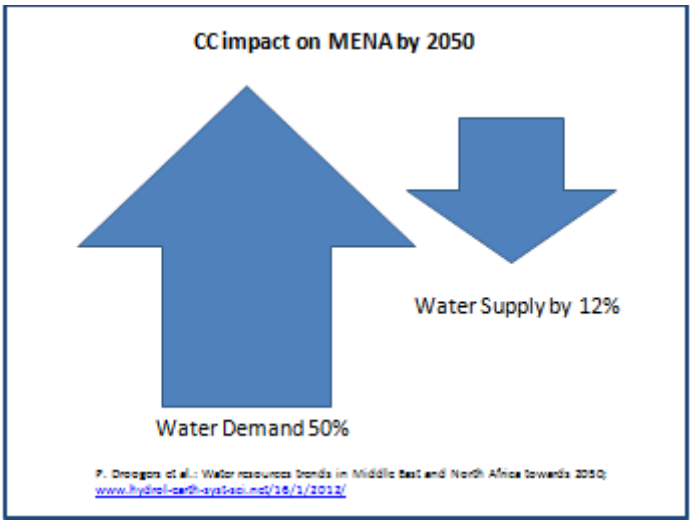


Figure 1 - CC impact on the MENA region by 2050

[1] World Bank. "Managing Water Resources in a Changing Climate." *Water Resources Management: Sector Profile*. 15 Apr. 2013.

As demonstrated by Figure 1, the CC impact on the MENA region by 2050 is expected to result in a 12% decrease in water supplies, while water demand is expected to increase by an additional 50%.[2]

> The water practices of the past will no longer be possible and the MENA region will have to adapt its water management strategies and practices to meet the challenges of the future.

Specifically, agricultural production, the biggest user of fresh water resources whereby is uses more than 83% of available water resources will have to improve its productivity per drop of water used.

Throughout history, communities in water short countries have had to adapt to water scarcity to ensure their survival, those that weren't able to adapt were not able to survive! From rainwater harvesting to complicated hand-build canals and systems, various technical solutions and mechanisms to deal with water shortages were developed. The MENA region is one of those regions that have had to grapple with water shortages for centuries. One of the ways water supplies have been augmented in a number of Arab States in the last few decades, has been through the reuse of Waste Water (WW), and Treated Waste Water (TWW).

As global and regional water scarcity increases, waste water (WW) reuse has been increasing to supplement or replace fresh water resourced in the agricultural sector. This practice has been happening worldwide, but undocumented in most cases as recent reviews has shown[3]. In the Arab countries, eighteen out of twenty two countries have reported the use of treated wastewater in agricultural production[4]. Reuse has mainly been for agricultural production and landscaping.

Globally, the agricultural sector uses more than 70% of total global fresh water withdrawal, 90 percent of global consumptive water use, and with some developing countries using as much as 95% of their water resources for agriculture. Concurrently, in most developing countries, agriculture employs the largest share of people and thus is critical for poverty reduction. Hence, it is not surprising that reuse of WW, partially TWW, and TWW for agricultural production has been happening around the globe for years. According to WHO, more than 10% of the world population consume food produced with TWW. Globally nearly 20 million hectares are currently irrigated with either TWW or untreated WW. In the Arab states alone, nearly 11 billion cubic meters of wastewater is produced annually, out of that about 5.6 billion cubic meters is treated to various levels of treatments. About 4.3 billion cubic meters of the TWW is used in agricultural production[5].

A recent review on the wastewater treatment and use on a global level showed that out of 181 countries studied; only 55 have information on three key aspects of wastewater: generation, treatment, and reuse. Another 69 countries have data on one or two aspects, 57 countries show no information on any aspect. However, for the Arab countries, and the MENA region in general, only Algeria and Iraq do not have complete information on wastewater generation,

[2] Karadjeh, Fawzi, and Mohammad Boufaroua. "Strategies to Augment Agricultural Water Shortages: Case Studies of Grey- and Treated Waste Water from Jordan and Egypt." The Use of TWW in the Agricultural Production in the Arab World: Current Status and Future Prospective. United Arab Emirates, Dubai. 15 Jan. 2014. Presentation.

[3] UN University 2013.

[4] ICBA-WB report in 2010.

[5] FAO-Aqua State 2010 and ESCWA, 2010.

treatment, and use. The extent of use of TWW clearly shows an increased awareness of the importance of such water resources in overcoming the shortages in conventional water resources available for agriculture[6].

Needless to say, WW and TWW reuse is here to stay, but it's wider scale adoption faces several challenges that need to be addressed by governments and technical experts, including: the limitations of TWW distribution networks, the institutional and legal challenges associated with public acceptance plus the absence of reuse standards and guidelines, and of course the economic and technical challenges of adopting new and different technologies, practices and cropping patterns.

Box 1 Water Reuse Terminology

Waste Water is liquid waste discharged by domestic residences, commercial properties, industry and agriculture, which often contains some contaminants that result from the mixing of wastewater from different sources. Based on its origin, wastewater can be classed as sanitary, commercial, industrial, agricultural or surface runoff. It is critical to differentiate between wastewater and sewage.

Treated Wastewater/Reclaimed Water is WW that has gone through various treatment processes to meet specific water quality criteria with the intent of being used in a beneficial manner (e.g. irrigation). The term recycled water is used synonymously with reclaimed water[7].

Grey Water is untreated WW from washing machines, showers, bathtubs, hand washing, lavatories and sinks that are not connected to toilet waste, and are not used for disposal of chemicals or chemical-biological ingredients.

Primary (Mechanical) Treatment is designed to remove gross, suspended and floating solids from raw sewage. It includes screening to trap solid objects and sedimentation by gravity to remove suspended solids.

Secondary (Biological) Treatment is designed to remove the dissolved organic matter that escapes primary treatment. This is achieved by microbes consuming the organic matter as food, and converting it to carbon dioxide, water, and energy for their own growth and reproduction. The biological process is then followed by additional settling tanks (secondary sedimentation) to remove more of the suspended solids.

Tertiary Treatment is simply additional treatment beyond secondary! Tertiary treatment can remove more than 99 percent of all the impurities from sewage, producing an effluent of almost drinking-water quality. The related technology can be very expensive, requiring a high level of technical know-how and well trained treatment plant operators, a steady energy supply, and chemicals and specific equipment which may not be readily available.

Quaternary Treatment is Tertiary treated wastewater with additional stage of treatment to bring it to drinking water standards like Ultra Filtration, UV and/or Chlorine disinfection and in some case up to the level of reverse osmoses.

Planned Use is the planned use of TWW for a beneficial use, such as agricultural irrigation and industrial cooling.

Unplanned Use is the application or discharge of untreated sewage onto agricultural lands or into surface waters.

[6] Global, regional, and country level need for data on wastewater generation, treatment, and use Toshio Sato, Manzoor Qadir., Sadahiro Yamamoto, Tsuneyoshi Endo, Ahmad Zahoor, Agricultural Water Management, Volume 130, December 2013, Pages 1–13).

[7] International Center for Biosaline Agriculture, Arab Water Council, and IAV Hassan II. *Water Reuse in the Arab World: From Principle to Practice*. Rep. N.p.: n.p., n.d. Print.

Global and Arab experts stressed during the 3-day workshop that TWW is a major new water resource globally and for the MENA region TWW can help address the exacerbating water scarcity. More importantly,

> TWW is a cheap and continuous resource that is available year round.

Nonetheless, **TWW can also be a hazard** that must be managed properly to ensure public health and minimize environmental hazards. Proper policies, standards, and practices must be applied and enforced to reduce hazards associated with WW and TWW.

A main concern of the reuse of WW and TWW for agricultural production is the environmental, health, and socio-economic impacts of this water, as well as the public perception of the edible products produced with this water. Some participants indicated that in some MENA countries, some consumers are concerned with the religious views regarding TWW and the products produced with this water.

CONFERENCE PROCEEDINGS

The Conference "The Use of Treated Wastewater in Agricultural Production in the Arab World: Current Status and Future Prospective", was held under the patronage of H. H. Sheikh Hamdan Bin Rashid Al Maktoum, Deputy Ruler of Dubai and Minister of Finance. It brought together more than 120 experts from the Arab region, and provided a forum for government representatives, planners, academia and development experts to discuss the current status of WW reuse, impact and future prospects. The conference was opened by H.E. Dr. Rashid Ahmed bin Fahad, Minister of Environment and Water; and, H.E. Dr. Ismahane Elouafi, Director General, International Center for Biosaline Agriculture. Followed by a high-level panel moderated by Ali Abdullah Al-Dhfiri, centered on Treated Waste Water (TWW) in 21 Century Agriculture. *The Conference Agenda, and participants list, are included in Annexes 1, 2 and 3.*

The conference provided participants with a forum to share global, regional and local experiences and lessons learned. Specifically, to:

- Present a global and regional outlook on TWW resources, technology and use;
- Give an outline of TWW resources in the Arab countries, and its use in agricultural production;
- Highlight lessons learned from the use of TWW resources in agricultural production and groundwater recharge.
- Discuss the nature and concerns related to the environmental impact and health aspects of reusing TWW.
- Present studies carried on the socioeconomics aspect of the use of TWW.
- Discuss and agree on the way forward.

During the course of the conference, representatives of ministries of environments, water and agriculture from Egypt, Jordan, Kuwait, Morocco, Oman, Saudi Arabic, Syria, Tunisia, UAE and Yemen, as well as experts from the World Bank, the World Health Organization, the

Islamic Development Bank, The International Water Management Institute (IWMI), the Food and Agriculture Organization of the United Nations (FAO), the International Center for Agricultural Research in the Dry Areas (ICARDA), ICBA and ACSAD discussed global and regional developments in the field of TWW reuse in agricultural production. Specific case studies were presented from several Arab States and lessons drawn were discussed. In total, 30 presentations were given. *Annex 3 provides synopsis on the presentations presented.*

During the last day of the workshop, participants were divided in three Working Groups (WGs) that discussed the information presented in the various sessions plus participants' personal knowledge and expertise. The purpose of the WGs was to agree on the current situation, existing gaps, and prepare recommendations on the way forward.

WG1: Current knowledge, gaps and future directions in the use of TWW in agricultural production;

Thirty participants joined WG1 tasked with identifying current knowledge levels and practices of TWW reuse in agriculture by academia, practitioners, policy makers and users. Additionally, WG1 discussed existing gaps in knowledge levels, use of TWW, and impact analysis in different Arab regions, plus identifying available resources and key expertise locally, regionally and globally. Finally, they deliberated future needs and priority areas for intervention.

WG2: Regulations and strategic planning;

Twenty participants joined WG2 tasked with identifying existing TWW strategic planning experiences locally, regionally and globally; as well as existing policies and regulations in the Arab States. WG2, also had to identify good examples and experiences that demonstrate key elements of successful implementation, and available resources and key expertise locally, regionally and globally. In conclusion, they discussed future needs and priority areas for intervention.

WG3: Partnerships, regional cooperation and future opportunities.

Fourteen participants joined WG3 tasked with identifying the current partnerships and regional cooperation programs related to TWW reuse globally, in the Gulf Cooperation Council (GCC) countries, and Arab States. Additionally, WG3 was tasked with discussing which donors are currently involved in TWW reuse and their interest, as well as which donors might be interested and lured into funding TWW reuse programs in the future. In conclusion the group identified that existing partnerships did exist at a number of levels and that these would need to be expanded and strengthened in order to take advantage of the funding opportunities that already exist and which could be captured.

FINDINGS

Saving water and increasing its productivity is a major global concern that has been on the top of the agenda of many countries especially those already suffering from chronic water shortages. In recent years,

> WW and especially TWW have been increasingly viewed as a viable, additional, dependable supply of water that can supplement the freshwater resources of the country.

Moreover, TWW is cheaper than all of the other alternatives for the additional water that is needed in the future to produce all the food demanded. In the last few decades, water and sanitation services have been steadily expanding with about 67% of the world's population projected to have access to sanitation services by 2105[8]. Worldwide, municipalities now produce about 330 km^2 of WW, however, what actually gets treated is about 20%. Urban areas are expected to grow considerably, as by 2050, 70% of the global population will be living in cities. This coupled with further improvements to sanitation services, will results in a continuous increase in WW supplies.

So far, reuse of TWW has largely been for agricultural production and landscaping, and some industrial uses. Approximately 10% of global irrigated area is currently irrigated with WW or TWW. Figure 2 showcases global WW and TWW reuse[9]. There have been some success at using TWW for municipal uses, such as the Singapore experience, but those have been isolated cases and have not yet gained wider adoption.

Throughout history, reuses of WW and TWW have been happening indirectly. For when communities discharge their WW or TWW into water streams, downstream communities withdrawing water from that water body are indirectly reusing it. However, in recent years, reuse of TWW has started to take a more formal and planned nature and TWW is now included in the water budgets of countries such as Jordan, United Arab Emirates, Saudi Arabia, Oman, Kuwait, Egypt, Tunisia, Morocco and Syria. Formal use of TWW started in several Arab countries in the early 80s, mainly for landscaping, agricultural production and later for some industrial uses. According to the WB representative, out of the US$4-5 billion allocated by WB to finance water and agricultural projects, only US$200 million is dedicated to WW treatment and reuse, and most of that is for the Middle East region.

Nonetheless, globally, only in 1 out of 10 WW reuse applications for agricultural production is officially planned, with many countries having more hectares under “informal” irrigation than in “formal” irrigation schemes with WW. Needless to say, when irrigating with untreated WW, there are a couple of environmental and health hazards that need to be properly addressed to mitigate damage, especially that untreated WW may contain pathogens, heavy metals, organic pollutants, all of which pose a threat to human health and the environment. The best scenario is to treat WW before reusing it, but that has its challenges as WW treatment is expensive and many poor countries cannot afford this additional burden on

[8] World Bank. " Foundations for Ending Poverty: Providing Sustainable Water and Sanitation Services." *Water Supply and Sanitation: Sector Results Profile*. 12 Apr. 2013

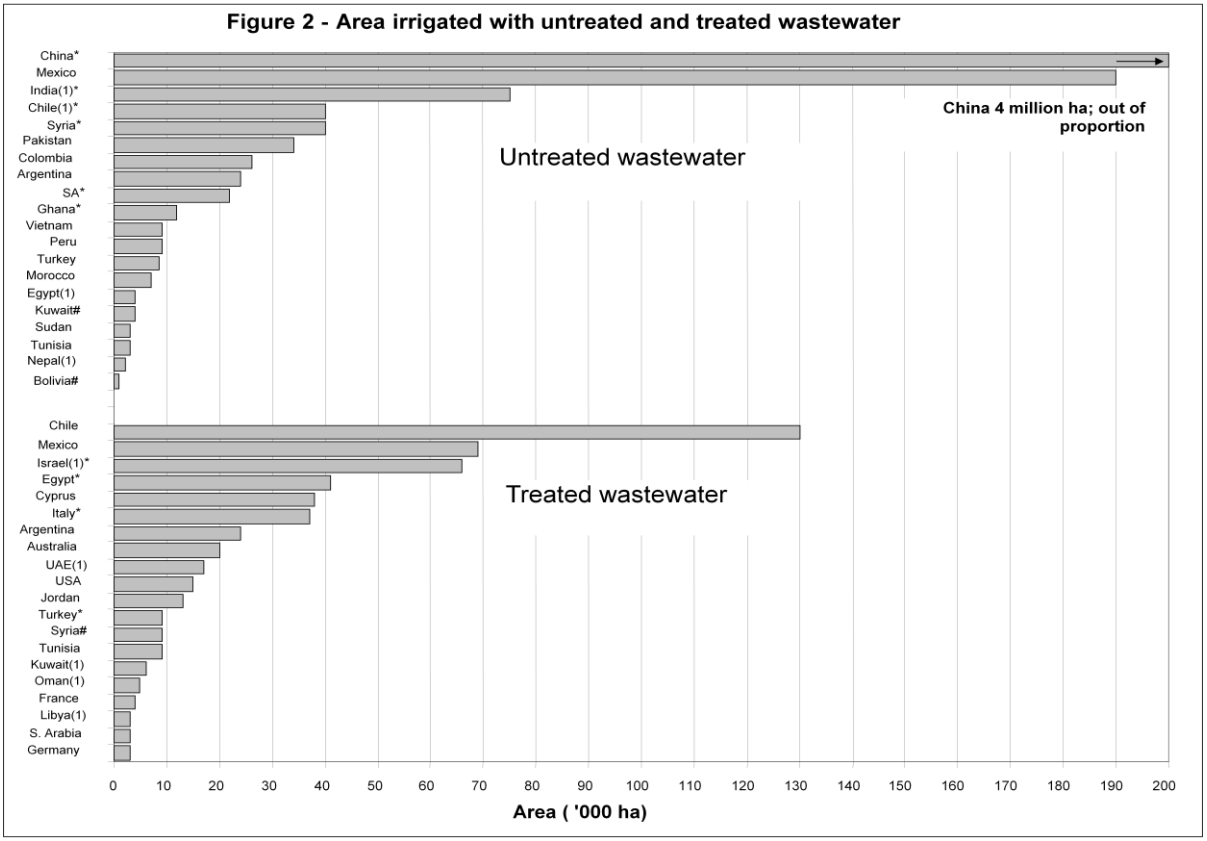
[9] Mateo-Sagasta, Javier. " Global perspectives on TWW use in agriculture." The Use of TWW in the Agricultural Production in the Arab World: Current Status and Future Prospective. United Arab Emirates, Dubai. 14 Jan. 2014. Presentation.

their national economy. This results in WW treatment plants that are poorly operated and maintained to the point that in many cases the water discharged from these treatment plants is untreated. Accordingly, experts expect that irrigating with untreated WW will continue into the future! In order to diminish damages, it is critical to

> cease unplanned irrigation with WW and ensure proper holistic management of irrigation schemes with WW in a manner that safeguards the health of the farmers, consumers and close communities, as well as minimizes damages to the environment.

Looking at Figure 2, we notice that on a global scale, China is, by far, the world's largest user of WW with 4 million hectares irrigated with WW. We also notice that 7 out of the top 20 countries using WW, and 9 out of the top 20 countries using TWW are from the MENA region.

Figure 2 - Area irrigated with untreated and treated wastewater



Public perceptions towards TWW reuse were continuously cited as a primary challenge, especially towards reuse of TWW for municipal uses. Research findings from the U.S. and Australia indicate that public resistance for reusing TWW for potable water supply is as high as 44-77%. While 7-21% are against using TWW for vegetable production even if it is highly treated, and 5% are against using TWW for landscaping[10]. Although, lack of trust in authorities and their enforcement of regulations and guidelines, as well as lack of knowledge which augments the perceived health risks of using TWW are main reasons for resisting

[10] Raschid-Sally, Liqa. "Addressing socio-cultural and institutional challenges for sustainable re-use." The Use of TWW in the Agricultural Production in the Arab World: Current Status and Future Prospective. United Arab Emirates, Dubai. 14 Jan. 2014. Presentation.

TWW reuse, the detrimental factor for this resistance is ultimately the "Yuck Factor"! Water shortage alone cannot overcome public resistance and disgust,

> what is needed is a holistic approach that brings in all stakeholders and builds trust and ownership of the TWW as it takes into consideration the interests of all involved including the ultimate users.

Farmers concerns and unwillingness to switch from irrigating with fresh groundwater resources to TWW, is another challenge. Although experience has shown that severe water scarcity, greatly facilitates farmers' acceptance and usage of TWW and even WW. Studies from Tunisia and Morocco even indicate farmers' willingness to pay to TWW although they had concerns about the effects on crop and soil quality. On the other hand, research showed that given the properties of TWW (organic carbon, nitrogen and phosphorus), it can improve the properties of the soil and increase its productivity. Also, using TWW usually results in better yields than when using fresh water and applying fertilizer.

Knowledge and understanding of the factors important when irrigating with TWW or WW is critical for maximizing benefits and minimizing negative impacts. It helps in choosing the right crops, applying the appropriate irrigation technology, and adhering to the suitable management practices. For example, when irrigating with WW or poorly treated WW, choosing the right irrigation technology can minimize the direct exposure of the farmers and workers to the WW, and selecting the appropriate crop minimizes public health issues.

Recognizing the health risks associated with WW use in agriculture, coupled with regulatory measures based on rigid guideline values whose application often were incompatible with the socio-economic settings where most wastewater use takes, the World Health Organization (WHO) initiated a rigorous Guidelines Development Process. The process included more than 100 experts representing national, regional and international stakeholders, and in 2006 published the "Guidelines for Safe Use of Wastewater, Excreta and Greywater", followed by two supplemental updates in 2008 and 2010. The WHO guidelines use a Risk Assessment and Management approach that looks into the full production circle, from the farmer receiving the TWW through cultivation and harvesting, up until the produce reaches the market. The aim of the guideline is to ensure the safety of the produce consumed by humans and minimize health and environmental impacts.

The WHO guidelines recognize that making the targets too severe, leads to lower adoption ratios and the continuation of existing unsafe practices. Hence, the standard provides a guiding tool of the methods, data, and references needed to allow different governments to tailor and develop their own standards that maximize public health and utilization of national natural resources according to specific country needs.

> A Key message of the workshop is that TWW reuse hazards must be minimized by adopting appropriate guidelines for reuse and standards for TWW used; and standards for the TWW used to produce agriculture produce eaten raw differs than the standards used for other agricultural produce.

There are many benefits to WW reuse. Conserving fresh water resources and protecting the groundwater is a primary need that necessitated reuse. Augmenting total water supplies with

a reliable source that is available year round is another major benefit that allows farmers to cultivate more crops year round. Importantly, TWW includes nutrients and organic matter that improve the soil and the crop yield. Indeed, farmers' incomes can increase when using TWW and the increased production can improve the food security situation of water scarce countries.

Environment is another major winner in the reuse equation, for exchanging unsustainable withdrawals from depleted aquifers with TWW; helps protect and sustain important groundwater basins. Treating the WW for reuse in agriculture lowers pollution from discharging untreated WW into water bodies and/or the environment. Moreover, TWW is available close to the vicinity of major cities, encouraging producing agricultural produce close to cities and minimizing energy required to transport agricultural produce to consumers in the cities.

Box 2 The WHO Guidelines on Safe Use of TWW in Agriculture

In 2006, WHO updated its WW reuse guidelines. The new Guidelines for the Safe Use of Treated Wastewater, Excreta and Greywater, propose a flexible approach of risk assessment and risk management linked to health-based targets that can be established at a level that is realistic under local conditions. The approach covers a range of policy, regulatory and standard-setting and is backed-up by strict monitoring measures. It aims at using best practices and making appropriate use of evidence.

The guidelines are based on Stockholm Framework for Risk Management and includes three steps:

1) Health risk assessment through: chemical and biological analysis, epidemiological studies, and qualitative microbiological risk assessment (QMRA).

2) Setting realistic and achievable health targets. These targets should be decided based on the first step and in view of the local circumstances.

3) Design the risk management system including a mixture of health barriers including wastewater treatment; die off periods; irrigation technology and several other barriers.

Guidelines for the safe use of wastewater, excreta and grey water. Volume 1: Policy and regulatory aspects

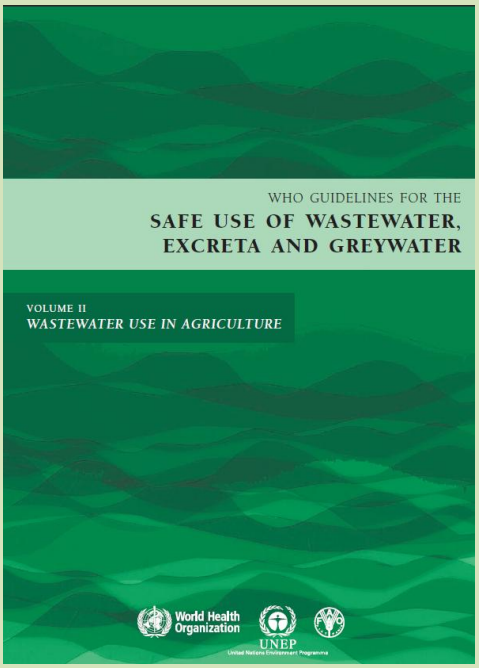
Guidelines for the safe use of wastewater, excreta and grey water. Volume 2: Wastewater use in agriculture

Guidelines for the safe use of wastewater, excreta and grey water. Volume 3: Wastewater and excreta use in aquaculture

Guidelines for the safe use of wastewater, excreta and grey water. Volume 4: Excreta and grey water use in agriculture

The guidelines and other related information are available at: http://www.who.int/water_sanitation_health/wastewater/en/

In order to make the WHO guidelines accessible to the broadest possible target audience and promote their implementation in a range of different settings, the need for a Manual on Wastewater Safety Plans has emerged. WHO is currently soliciting contributions for developing this manual.

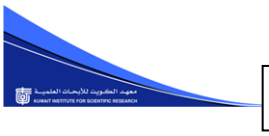


The development of global guidelines on safe use of TWW in agriculture and aquaculture is one of the WHO core functions.

There are major costs associated with WW collection, treatment and conveyance, especially when treatment is up to tertiary levels. More so, when the fresh water supplies themselves are from costly desalination water as is the case in most of the Arab Gulf countries. In these countries subsidies to the water production phase is enormous and allowable only because of the high remittance of oil production. Figure 3[11], demonstrates the extend of these subsidies.

Water subsidies in GCC

Country	Total Production in in million cubic metres	Cost US$/m³	Revenue US$/m³	Subsidies		
				In US$ million	% of GDP	% of Oil Export revenue
Bahrain	115	0.65	0.17	55	0.7%	1.4%
Kuwait	520	1.98	0.19	832	**2.4%**	**5.9%**
Oman	169	1.34	0.84	85	0.4%	1.1%
Qatar	132	1.31	0.42	117	0.7%	1.3%
Saudi Arabia	2500	1.35	0.08	3175	1.7%	7.0%
UAE	831	1.16	0.13	856	1.2%	2.1%



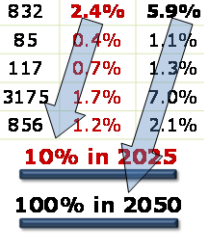


Figure 3

There are on-going deliberations within the sector on who shoulders the bulk of the treatment cost? Is it the cities? Governments? or farmers?. One thing that almost all experts agree to, is that when reflecting the infrastructure costs, the cost of TWW is a very high cost that farmers are unwilling and unable to pay especially in light that many of them are currently receiving very cheap water. There is a general consensus that polluters (cities) need to shoulder the bulk of these costs especially that aside for the reuse of the TWW in agriculture, cities need to clean their WW before discharging it into the environment to minimize pollution! On the other hand, experts agree that the predominantly low prices of agricultural water, especially in the water-scarce MENA region, cannot continue if usages of water resources are to be optimized! Water prices for all uses (municipal, industrial and agricultural) need to be reformed to better reflect the true value of this scarce resource which will incentivize users to optimize usage. The difficulty here is ensuring political will for this unpopular decision amongst users, especially agricultural users which inherently have considerable political clout.

Moving forward, a major prerequisite for WW reuse is the need for building the collection, treatment and conveyance infrastructure. In most of the oil-rich Gulf countries, extensive infrastructure is in place for treating WW up to tertiary and higher levels, and even more extensive schemes are underway. Despite the challenges associated with the public and decision makers' perception of reuse, the United Arab Emirates, Saudi Arabia, Kuwait, and Oman have impressive programs underway that can be used as a model by others. The scenario is quite different in the less affluent Arab countries, where water treatment collection is more in line with international averages and where wastewater, if treated, is usually up to secondary standards with Jordan, Egypt, Tunisia and Morocco leading the reuse efforts.

To-date, little research into the socio-economic-health benefits and costs of reusing treated has been carried globally and in the MENA region. As WW and TWW reuse spreads across countries, extensive economic and social analysis are needed to closely examine the benefits and costs and propose a sound way forward.

[11] Akber, Adnan. "Use of Tertiary Treated Wastewater in Irrigation Activities: A Case Study from Kuwait." The Use of TWW in the Agricultural Production in the Arab World: Current Status and Future Prospective. United Arab Emirates, Dubai. 14 Jan. 2014. Presentation.

CURRENT KNOWLEDGE, GAPS AND FUTURE DIRECTIONS

Throughout the course of the three-days, presenters outlined benefits of reusing TWW along with the hazards and challenges. Global trends were discussed as was progress made in the MENA region in reusing WW, secondary TWW and tertiary TWW. During the last day of the conference, thirty experts from the region convened in a Working Group (WG1) to discuss current knowledge levels and practices of TWW in agriculture by academia, practitioners, policy makers and users. Identify existing gaps in knowledge levels, use of TWW, and impact analysis in different Arab regions. Available resources and key expertise locally, regionally and globally were categorized. Future direction and needs were discussed and priority areas for intervention singled out.

The WG was provided with the following guiding questions to lead the discussion:

What is the current state of affairs of TWW reuse in Agriculture, globally, in the Gulf region and other Arab States?.

What are the current knowledge levels, perceptions, and practices/ malpractices in the Arab region?

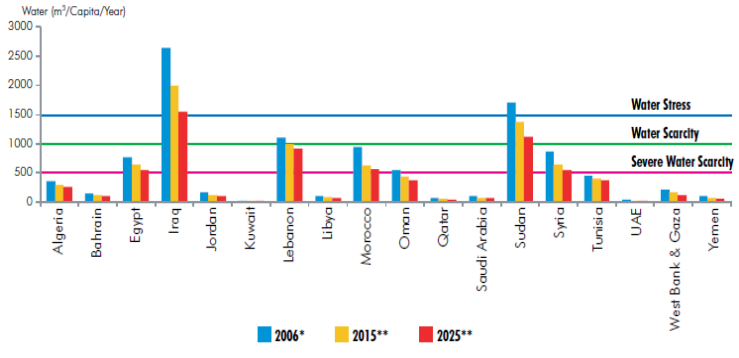
Which countries in the region have applicable or extensive TWW reuse programs that could benefit other countries with lessons learned?

What are the leading institutions in TWW reuse research and/or implementation, and who are the key experts?.

Identify existing TWW reuse programs-other than the ones presented in the conference - that need to be assessed and studied.

Following is a summary of the findings of this WG. Their recommendations are incorporated in the Recommendations Section.

Given the severe water scarcity in the MENA region, the reuse of WW in Arab countries is no longer an option but a need as demonstrated in Figure 4[12]. In actual fact, reuse of both WW and TWW in agricultural production has been occurring directly and indirectly in all the MENA countries for years, some as early as the 1970s. In fact, many Arab countries are leading the way for the reuse of TWW in agriculture, landscaping, environmental protection and some industries. Planned reuse activities have been on-going in



[12] Al-Mullah, Mohamed. "Strategic Priorities of the Use of TWW in the UAE." The Use of TWW in the Agricultural Production in the Arab World: Current Status and Future Prospective. United Arab Emirates, Dubai. 14 Jan. 2014. Presentation.

Saudi Arabia and Tunisia for more than 30 years. Tunisia laws and regulations governing TWW reuse in agriculture date back to 1975.

The oil rich countries of the Gulf region are clearly leading the way in building extensive sanitation networks and treatment plants that treat wastewater up to the highest standards (tertiary and above). The main driver for this treatment and reuse of the WW is the scarcity of available water resources coupled with the dependency on very costly desalination water to supply municipal demand. Initially, TWW was used for landscaping and some soft industries and the surplus disposed off in water streams. In recent years, and due to the considerable high costs of this TWW, the water has been increasingly used for unrestricted agricultural production, plus for managed aquifer recharge to halt seawater intrusion. There are various on-going studies (in countries like UAE and Oman) to examine feasible reuse options in various agricultural production systems, in groundwater recharge, landscaping and other environmental rehabilitation projects.

The reminder of Arab countries including Tunisia, Jordan, Syria, Egypt, Morocco and Yemen, mostly rely on secondary treatment of WW. Most of these countries have had reuse programs going-on for decades with Tunisia leading the way, closely followed by Jordan and Egypt. The overall experience of these countries demonstrate the TWW reuse is feasible, but they do recommend crop restrictions especially on crops eaten raw and when crops are irrigated with WW. For the future, experts recommend that for long-term use of TWW, their countries need to move to tertiary treatment in order to improve public acceptance plus minimize negative impacts and built-ups in the soil and environment.

Development of comprehensive management practices for irrigation including the use of different hoses color, crop selection, cultivation methods, fertilization, crop TWW requirement, handling of the products, harvesting, etc... is needed and should be viewed as a priority. Regional cooperation and sharing of lessons learned from similar conditions can greatly reduce time and efforts.

Advances in TWW Reuse in the MENA Region:

UAE: Abu Dhabi Emirate is currently exploring wider scale use of TWW to recharge aquifers to halt seawater intrusion into ground water basins.

Tunisia: Tunisia is one of the first Arab States to reuse TWW for agricultural production and have since 1975, laws that outline the best use of TWW, the authorized crops, and guidelines for irrigating with TWW.

Oman: is implementing active aquifer recharge with TWW affluent of tertiary standards through injection and infiltration.

Jordan: the Al-Samra WW treatment plant generates electricity from the sludge in the WW to cover most of its energy needs.

Saudi Arabia: groundwater depletion threatened the unique agro-ecosystem of Al Hassa Oasis in eastern KSA. An extensive system of collection, treatment, and transport of TWW from neighboring cities was designed together with an extensive irrigation system that currently services about 16,000 hectares. By 2016, the whole area will be irrigated with TWW.

Kuwait: Sulaibiya Wastewater Treatment Plant is the largest membrane-based water reclamation facility in the world. The facility daily converts 380,000 m^3 of municipal effluent to 320,000 m^3 of high-quality reclaimed water that is used for agriculture. The plant's daily capacity is expandable to 610,000 m^3.

Overall, monitoring systems for TWW reuse do exist in all of the countries in the region, but they are insufficient and need to be updated, more so for those reusing secondary TWW. Similarly, several economic analysis and impact studies have been carried (soil, crop,

aquifer), but many gaps still exist and there is a need for a comprehensive evaluation at the field level as well as at macroeconomic, human, environmental impact, value chain, extension, management, andirrigation analysis.

Although many countries in the MENA region already have their internal governing laws and regulations pertaining to TWW reuse, these need to be reviewed and revised to ensure harmony and ease of enforcement. Additionally, experts at the 3-day conference discussed the benefits of having standards for the end products as well as developing common standards (guiding standards) for the Arab countries based on the level of WW treatment. Concurrently, there is need for accountable institutes for the use of TWW established within each country/ministry that will be responsible for monitoring and enforcement to ensure the highest standards of health and safety. Political commitment is KEY.

Although, TWW reuse is expanding in the area with many governments already including it in their water budgets and some developing specific strategies for TWW reuse, public acceptance is still relatively low and much work is needed in this area. There is a need to engage all the stakeholders and different government organizations from the start and throughout the various stages of implementation to build ownership. Public outreach and education efforts especially to farmers are critical, as is training and capacity building of extension personnel, and ensuring product quality. Collectively, these efforts will increase farmer and public acceptance.

Several environmental impact assessments have been carried, but these have mostly been done within individual country, and even within a specific agency in the country. Findings and data generated are not accessible and often shared with limited responsible agencies. There is a noticeable need in carrying broader and more extensive assessments, plus there is a lack in specialized facilities for advanced analysis and high cost (like heavy metals, etc), and a need to establish a common formal platform for sharing within countries and at a regional level.

Advances in TWW Reuse in the MENA Region:

Egypt: intensive farming of rice and aquaculture using TWW in the north Delta Region as a means to recharge the underground aquifer and stop seawater intrusion.

Syria: Total areas irrigated with TWW reached more than 37,000 hectares, constituting 2.6% of irrigated area in Syria. Studies were carried to assess the impact of using sewage sludge on soil and crops.

Morocco: Extensive TWW reuse hase been on-going in Marrakech in partnership with the private sector Wastewater. Specifically, partnering with the private sector in building and operating a tertiary treatment plant that produce over 90720 m^3/day leading to the conservation of Marrakesh's Palm grove; saving 33 Million m^3/year of fresh water, plus developing extensive golf courses that support tourism and the economy of the region.

Yemen: Currently Yemen uses 30 million m^3 for its agricultural production. TWW can potentially save 7-10% of the water used in agricultural. So far, 20,000 ha is irrigated with TWW, mainly in the highlands where it is used for forage and cereals crop production. In the coastal areas, TWW is used to establish green belts to stabilize active sand dunes. However, long term use of primary treated wastewater has negatively .impacted soil environment

Most Arab countries by now have developed internal expertise on the use of TWW. However, there remains a shortage in specialized researchers, centers and specialized extension staff. Developing a database on technical and institutional expertise will be a great aid.

REGULATIONS AND STRATEGIC PLANNING

Given the importance of instituting proper policies, plans and regulations for wide-scale adoption of WW reuse, a large portion of the presentations and discussions during the conference focused on strategic plans and governmental policies adopted by Arab States that encourage, govern and monitor WW and TWW reuse.

During the last day of the workshop, twenty experts from the region convened in WG2 to identify existing strategic planning experiences locally, regionally and globally, specifically existing policies and regulations in the Arab States. Discuss good examples and experiences that demonstrate key elements of successful implementation and available resources and key expertise locally, regionally and globally. Future direction and needs were discussed and priority areas for intervention singled out.

The WG was provided with the following guiding questions to lead the discussion:

- What are the wastewater resources in the Arab countries and their level of treatment?
- What are the existing regulations pertaining to TWW reuse in the Arab States? Are these regulations adequate? Are they being applied?
- Which countries did strategic planning for TWW reuse? have regulations/policies/ standards for TWW reuse?
- What are the issues they faced?
- What are the main lessons learned/issues to be avoided?
- How can strategic planning be improved?
- Identify existing examples - other than the ones presented in the conference - that need to be assessed and studied?
- What is the role of research?
- What are the leading institutions in Strategic Planning and Policies related to TWW reuse? Who are the key experts?

Following is a summary of the findings of this WG. Their recommendations are incorporated in the Recommendations Section.

Generally speaking TWW is considered a strategic resource in all MENA countries as it provides them with a source of water that helps them deal with the water scarcity they are facing. Many countries have specific strategies and policies related to TWW reuse, and TWW is reflected in the countries' water budgets. Appropriate standards and regulations that are properly enforced are key to sustainable reuse of TWW, for they build user and public acceptance and ensure safe produce. 60-70% of the GCC countries have regulations and standards, as do 40% of the other Arab countries.

Most water and WW strategies of the Arab Countries portray an integrated water management approach, but in reality, actual implementation is facing many challenges including:

Financial constraints, as expansion of WW collection and treatment services is costly, both capital wise and operation wise. Furthermore, conveyance and storage systems are needed for reusing the TWW, these are costly too. On the other hand, the prices of fresh water in most Arab countries are very low and don't reflect the true value of this resource and resulting in a very low user willingness to pay for TWW.

Table 1- TWW Reuse in select MENA countries is based on:

Country	Regulations	Risk Assessment	Monitoring	*Notes*
Egypt	Yes		Yes	
Jordan	Yes - 85%	Yes	Yes	
KSA	Yes	No		
Oman	Yes	No		
Syria	Yes	No		
Tunisia	Yes	No		
UAE	Yes	Yes - partially	Yes	*Planning 2014-15*
Yemen	Yes	No		
Iraq	Yes	No		

Environmental constraints, as reuse of TWW is not properly treated and handled has both health and environmental hazards that affect the soil, crop, underground water and the safety and health of the users and surrounding communities.

Socio-culture constraints related to farmers' willingness to switch from the free groundwater they are currently getting to TWW. Also, consumers perceptions and their perceived religious reservations about consuming crops irrigated with TWW. Last but not least, the decision makers' perception of the risk associated with TWW reuse.

Policy and regulations constraints, especially that proper enforcement of standards and regulations is to sustainable reuse of TWW, as it builds user and public acceptance and ensures safe produce. In Arab countries, current regulations and standards are thresh-hold based standards that are rigid in application and don't take into consideration local circumstances. Contrary to the revised WHO standards that are risk assessment based and built around local environments. Moreover, they are conservative and strict which makes enforcement difficult. There is consensus that they need to be revised and made more flexible to accommodate safe use. Concurrently, most of the Arab countries don't have monitoring systems for the crops, while this is essential for reliability, traceability, and corrective actions, as is a priority area for future intervention.

Overlapping responsibilities between agricultural authorities and other institutions, agencies, and entities working in WW treatment reuse, consumer protection, and public health. A participatory and multi-stakeholders approach should be followed.

Transparency between countries including export and import of goods needs to be enhanced in a manner that ensures sustained cooperation, trust, safety and public health.

Awareness and outreach among the various stakeholders including other institutions involved, farmers, consumers, communities surrounding TWW reuse sites as well as extension personnel.

Though the Arab States have different reuse projects using both secondary TWW and Tertiary TWW for landscaping, agricultural production, industrial uses, district cooling, and nature conservation, much more needs to be done. Aquifer recharge and nature conservation need to be further studied and explored. Pilot projects are needed to examine the potential use of TWW for aquaculture, as well as explore how reuse of TWW in the agricultural and industrial sectors can be diversified.

PARTNERSHIPS, REGIONAL COOPERATION AND FUNDING OPPORTUNITIES

Since finding the required resources to tackle the research and development required in the use of TWW is a main challenge for any new approach, and funding is key for carrying the needed research and outreach, the organizers made certain to include a few presentations to discuss possible financing options and direction. Also, during the last day of the conference, 14 experts from the region convened in WG3 to discuss current partnerships and regional cooperation programs related to treated wastewater reuse and identify existing and potential funding opportunities locally, regionally and globally, and discuss next steps.

The WG was provided with the following guiding questions to lead the discussion:

- What are the current partnerships related to TWW reuse in Agriculture? In the Gulf region? Other Arab States? Globally?
- What are the existing regional cooperation programs?
- Which donors are currently involved in TWW reuse? What are their main interests?
- Which donors may become involved in the future? What may encourage them?

Following is a summary of the findings of this WG.

There are a number of on-going partnerships in the MENA region on all levels: international partnerships, bilateral partnership (i.e. GCC), and between some Arab states. Similarly, there are a number of donors that are already active in funding reuse projects in this region including International Fund for Agricultural Development, German Society for International Cooperation, European Union, United States Agency for International Development, International Development Research Centre, and the Food and Agriculture Organization. Additionally, there are some private companies (e.g. Coca Cola) and foundations (e.g. Volkswagen) that are also providing funding in this field.

However, future needs are enormous and as water shortages increase, it is expected that funding TWW reuse initiatives will become higher on the agenda of many donors especially if they can be linked with the developmental priorities of those donors. Specifically, the WG members thought that the following donors can be approached to support reuse programs:

European Neighborhood and Partnership Instrument;

On-going and upcoming regional projects funded by regional and international donors;

Private international companies (such as General Electric);

High water consuming Arab industrial companies (Saudi Arabian Oil Co (ARAMCO), Organization of the Petroleum Exporting Countries);

European Universities funded by European Union as well as the German Research Foundation;

Swedish International Development Cooperation Agency (Sida)

Global Environmental Facility;

Islamic Development Bank, African Development Bank Group, Arab Bank for Economic Development in Africa, Islamic Educational, Scientific and Cultural Organization, Kuwait Fund for Development;

Japan International Cooperation Agency.

The WG identified several high priority areas of intervention that need to be urgently pursued including the establishment of a platform for exchange information on research, formulating best practices, sharing success stories, acting as a center of excellence, formulating a network of experts at regional and country levels, plus providing expert advice.

Putting together an "Information Memorandum" on the WW reuse sector prospects and needs and sending that to potential donors to open doors for discussing cooperation and funding opportunities was also identified as a good starting step.

The remaining recommendations of the WG are incorporated in the Recommendations Section.

RECOMMENDATIONS

During the course of the three-day conference, several solutions, messages and recommendations were proposed by participants either in the plenary discussions or in the WGs. The key recommendations are outlined below:

A comprehensive approach for the use of TWW must be developed from treatment, to land and crop selection, on-farm practices etc... This approach needs to be build on the basis of stakeholder engagement in all aspects, and a product of this approach should be country-wide strategic plans that take into account the socio-economic-environmental aspects and reflect the interests of the users and consumers. This approach needs also to consider, define and streamline the roles and responsibilities between the different agencies and reflect that in the national plans.

Standards and Regulations need to be revised and updated. They need flexible, clear and built on a risk assessment/management approach. The standards and guidelines for reusing TWW should differ according to the level of WW treatment (secondary different than tertiary) to ensure safe use. Standards for crops need to be looked into to facilitate import/export of safe agricultural produce.

It is essential to ensure continuous and sustainable monitoring programs/systems. For monitoring is a prerequisite for enforcement of the standards and regulations and is critical for ensuring public safety and protecting the environment.

Best Practices Guidelines should be developed for the Arab countries. These must cover the whole range of management practices associated with reuse of TWW including crop selection, handling of the TWW, irrigation, harvesting, post harvesting and marketing. Extension material need to be developed and shared. Terminology needs to be identified across the region and agreed.

Extensive capacity building and training to support appropriate and safe TWW reuse is needed at many levels. Specifically, there is a eminent need to build the expertise of specialized experts and extension staff that could work with the users of the TWW. Capacity building is also needed within the public institutions to facilitate establishing specialized/ accountable institutions specializing in the field to TWW reuse; regional and at country level. Establishing scholarships in the areas of expertise needed is lacking and was seen as an important tool.

More regional cooperation/partnerships is needed among the countries and building a regional platform/network of institutions and experts was deemed as

a necessity to facilitate sharing of results, information, lessons learned, and best practices. This platform can also take responsibility for unifying terminology; developing the Best Practices Guidelines; publishing research; setting up a database for Arab technical and institutional expertise; leading multidisciplinary research; facilitating information exchange among countries; capacity building, and leading the development of a Memorandum of Understanding between the Arab Countries on TWW reuse.

Stakeholder engagement, outreach and communications are needed at all levels. There are environmental and public health risks associated with TWW use, that need to be precisely defined and mitigated. Hence, more studies and research are needed on the socio-economic-environmental impacts of reuse. Results and lessons learned should be disseminated and shared on a broad base, and projects up scaled.

There are funding opportunities both from international and regional funding organizations as well as some private companies that need to be considered and approached. An immediate next step will be to put together an "Information Memorandum" on the TWW reuse to send to donors and follow it up with meetings.

ANNEXES

ANNEX 1:CONFERENCE AGENDA

Day 1: Tuesday 14 January 2014

08:00-09:00	**Registration**
09:00-09:30	**OPENING SESSION**
09:00-09:05	National Anthem
09:05-09:10	Recitation from the Holy Quran
09:10-09:20	Speech of the **Patron of the Conference, HE Dr Rashid Ahamed bin Fahad**, Minister of Environment and Water (MOEW)
09:20-09:30	Welcome Speech **HE Dr Ismahane Elouafi**, Director General, International Center for Biosaline Agriculture (ICBA)
09:30-10:00	**COFFEE BREAK**
10:00-11:30	**POLICY FORUM ON: TREATED WASTEWATER IN 21ST CENTURY AGRICULTURE**

Moderator: Ali Abdullah AlDhifiri

HE Eng Saif Al Sharaa, Undersecretary for Agriculture and Animal Wealth Affairs Department, Ministry of Environment and Water, UAE

HE Dr Farid Mejwer, Minister of Agriculture and Irrigation, Yemen

HE Dr Ishaq Al-Ruqaishi, Ministry of Agriculture and Fisheries, Sultanate of Oman

HE Dr Ismahane Elouafi, Director General, International Center for Biosaline Agriculture

Dr Basel Alyousifi, Director, Regional Center for Environmental Health Action, World Health Organization

Dr Steven Schonberger, Sector Manager for Water and Agriculture, Middle East and North Africa Region, The World Bank

11:30-14:00 **PLENARY SESSION (PART I)**

Global Outlook on Treated Wastewater (TWW) Resources, technology and Use

Chair: Mr Fawzi AlSultan **Rapporteur: Dr Redhounae ChoukrAllah**

11:30-12:00	*Global perspectives on TWW resources and use in agriculture* **Javier Mateo-Sagasta,** International Water Management Institute (IWMI)
12:00-12:30	*Global perspectives in the use of treated wastewater resources in agricultural production* **Liqa Raschid Sally,** International Water Management Institute (IWMI)
12:30-13:00	*Guidelines and standards in the use of TWW: new directions* **Basel AlYousfi & Eng Mazen Almalkawi,** World Health Organization (WHO), Regional Center for Environment Health Action
13:00-13:30	*World Bank's experience in supporting wastewater reuse - lessons and future prospects*

Dr Steven Schonberger, Sector Manager for Water and Agriculture, Middle East and North Africa Region, The World Bank (WB)

13:30-14:00 **Discussion/Forum**

14:00-15:00 **LUNCH BREAK**

15:00-17:30 **PLENARY SESSION (PART II)**

Regional Outlook on Treated Wastewater (TWW) Resources, technology and Use

Chair: Dr Shoaib Ismail **Rapporteur: Eng Mazen Almalkawi**

15:00-15:20 *Current status of treated wastewater resources in the Arab World and their use in agricultural production*
Omar Jouzdan, Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD)

15:20-15:40 *Potential use of TWW in GCC countries*
Alberto Del Lungo & Muhammad Akhtar Bhatti, Food and Agriculture Organization of the United Nations

15:40-16:00 *Strategic priorities of the use of TWW in the United Arab Emirates*
Mohamed Al Mulla, Ministry of Environment and Water (MOEW)

16:00-16:20 *TWW technology and use: experience from the Gulf region*
Said Ben Khamis Al-Muslehi, Haya Company, Oman

16:20-16:30 *Experiences and achievements of the Kingdom of Saudi Arabia in the use of TWW in Agricultural Production – Part 1*
Fahed Al Moammar, Ministry of Agriculture, Kingdom of Saudi Arabia

16:30-16:40 *Experiences and achievements of the Kingdom of Saudi Arabia in the use of TWW in Agricultural Production – Part 2*
Abdul Aziz Rashoud Al Rashoud, Ministry of Agriculture, Kingdom of Saudi Arabia

16:40-16:50 *Experiences and achievements of the Kingdom of Saudi Arabia in the use of TWW in Agricultural Production – Part 3*
Abdullah Bu Tuwaiba, Ministry of Agriculture, Kingdom of Saudi Arabia

16:50-17:30 **Discussion/Forum**

19:30 **Gala Dinner**

Day 2: Wednesday 15 January 2014

08:30-11:30 **Technical Session I**

Treated Waste Water Resources and Use in Agricultural Production

Chair: Dr Abdullah Dakheel **Rapporteur: Dr Nurul Akhand**

08:30-08:50 *TWW resources and current and future utilization in Abu Dhabi*
Mohammad Abdul Hameed Dawod, Water Resources Advisor, Environment Agency – Abu Dhabi (EAD)

08:50-09:10 *Current and future plans for the use of TWW in agricultural production in Abu Dhabi Emirates*
Alaa Juma, Abu Dhabi Food Control Authority (ADFCA)

09:10-09:30 *Strategies to augment agricultural water shortages: Case studies of grey- and treated waste water from Jordan and Egypt*
Fawzi Karajeh, International Center for Agricultural Research in the Dry Areas (ICARDA)

09:30-09:50 *Research and successful interventions to increase efficiency and effectiveness of treated wastewater reuse in agriculture in Morocco*
Redouane ChoukrAllah, Al-Hassan Al-Thani Institute for Agronomic Research, Morocco

09:50-10:10 *Tunisia Experience in the use of TWW in Agricultural production: Highlights and lesson learned*
Mohamed Hachicha, National Research Institute for Rural Engineering, Water and Forestry (INRGREF), Tunisia

10:10-10:30 *Forage Production Using Treated Wastewater in Jordan: Achievements and Aspirations*
Mohamed Al-Riafee, National Center for Agricultural Research and Extension (NCARE), Jordan

10:30-10:50 *Impact of the Use of TWW in Agricultural Production in Syria*
M Manhal Al Zoubi, General Commission for Scientific Agricultural Research, Syria

10:50-11:10 *Utilization of TWW resources in Egypt*
Hassan Mazen, Ministry of Water Resources and Irrigation, Egypt

11:10-11:30 **Discussion**

11:30-11:45 **COFFEE BREAK**

11:45-13:30 **Technical Session II**

The use of TWW in Agricultural Production and ground water recharge: Highlights and lesson learned

Chair: Dr Liqa Rachid Sally **Rapporteur: Dr Dionyssia Aggeliki Lyra**

11:45-12: 05 *Treated Wastewater Irrigation in Crop Production in Oman: Highlights and Lessons Learned*
Saif Al Khamisi, Directorate General of Agriculture and Livestock Research, Oman

12:05-12:25 *The Use of Treated Sewage Water for Afforestation, Desertification Control and Biofuel Crop Production in Egypt*
Raafat Khidr, President, Desert Research Center (DRC), Egypt

12:25-12:45 *Storing Treated Waste Water Underground and its' Use for Growing Crops: A Case Study from Oman*
Mushtaque Ahmed, Associate Professor, College of Agricultural & Marine Sciences, Sultan Qaboos University, Oman

12:45-13:05 *Artificial recharge of aquifer by TWW in Oued Souhil – Nabeul area: Effect on soil and groundwater characteristics*
Mohamad Hachicha, Senior Researcher, National Research Institute for Rural Engineering, Water and Forestry, Tunisia

13:05-13:30 **Discussion**

13:30-14:30 **LUNCH BREAK**

14:30-17:15 **Technical Session III**

Environmental impact and health aspects: (Soil, Water and Health Impact)

Chair: Prof Dr Mohamed Ali BEN ABDALLAH **Rapporteur: Dr Mushtaque Ahmad**

14:30-14:50 *The importance of heavy metal elements in environmental pollution and danger to human health*
Omar Jouzdan, Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD)

14:50-15:10 *Use of Tertiary Treated Wastewater in Irrigation Activities: A Case Study from Kuwait*
Adnan Akber, Director, Science & Technology Division, Water Research Center, Kuwait Institute for Scientific Research (KISR), Kuwait

15:10-15:30 *Impact of Treated Wastewater on Soil and Plant Constituents: Highlights of research from Oman*
Saif Alkhamisi, Directorate General of Agriculture and Livestock Research, Oman

15:30-15:50 *Impact of Treated Wastewater Irrigation on Soil Environment: Case Study of Jordan*
Khalil Jamjoum, National Center for Agricultural Research and Extension, Jordan

15:50-16:10 *Irrigation of citrus orchards with treated wastewater in northern Tunisia: Effects on microbiological quality of soil and fruits*
Monia Trad Raïs, National Research Institute for Rural Engineering, Water and Forestry, Tunisia

16:10-16 :30 *Health Aspect of Reuse of Treated Wastewater under Different Methods of Irrigation*
Nabeel Bani Hani, National Center for Agricultural Research and Extension, Jordan

16:30-16:50 Assessment of pathogens and heavy metals contamination in vegetables grown with treated wastewater in the UAE **Nurul Akhand,** Irrigation Management Scientist, International Center for Biosaline Agriculture (ICBA)

16:50-17:15 **Discussion**

Day 3: Thursday 16 January 2014

09:00-10:45 **Technical Session IV**

Socioeconomics aspects of the use of TWW

Chair: Dr Fawzi Karajeh **Rapporteur: Dr Berhanu Degefa**

09:00-09:20 *An economic framework for wastewater irrigation*
Javier Mateo-Sagasta, International Water Management Institute (IWMI)

09:20-09:40 *The social acceptability and economic analysais of TWW use in agriculture: A Tunisian case study*
Hacib El Amami, National Research Institute for Rural Engineering, Water and Forestry, Tunisia

09:40-10:00 *Assessing the Impact of using Treated Wastewater and Fresh water on the socio economics of Farmers in the Jordan Valley*
Amer Salman, University of Jordan, Jordan

10:00-10:20 *Economic and Social Aspects of the Use of Treated Wastewater: A Case Study from Oman*
Slim Zekri, Associate Professor, College of Agricultural & Marine Sciences, Sultan Qaboos University, Oman

10:20-10:45 **Discussion**

10:45-11:15 **COFFEE BREAK**

11:15-13:30 **Session V** **Roundtable Discussion Groups - Concurrent Sessions**

Group 1: Current knowledge, gaps and future directions in the use of TWW in agriculture production

Group 2: Regulations and Strategic planning

Group 3: Partnerships, regional cooperation and funding opportunities

13:30-14:30 **LUNCH BREAK**

14:30-16:30 **Session VI** **Outcome and conclusions**

Highlights and Outcome of roundtable discussion Groups

Conclusions and Recommendations

Closing remarks, Mr Fawzi AlSultan, Chairman of ICBA Board of D

ANNEX 2:PARTICIPANTS LIST

List of Panel Participants

No	Name	Job Title	Organization	Country
1	**HE Eng Saif Al Sharaa**	Undersecretary for Agriculture and Animal Wealth Affairs Department	Ministry of Environment and Water	UAE
2	**HE Dr Farid Mejwer**	Minister of Agriculture and Irrigation	Ministry of Agriculture and Irrigation	Yemen
3	**HE Dr Ishaq Al-Ruqaishi**	Advisor to the Minister	Ministry of Agriculture and Fisheries	Sultanate of Oman
4	**HE Dr Ismahane Elouafi**	Director General	International Center for Biosaline Agriculture	UAE
5	**Dr Basel Alyousifi**	Director, Regional Center for Environmental Health Action	World Health Organization	Jordan
6	**Dr Steven Schonberger**	Sector Manager for Water and Agriculture, Middle East and North Africa Region	The World Bank	USA
7	**Mr Ali Al Dhafiri**	Moderator	Al Jazira Channel	Kuwait

List of Conference Participants

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2	**Abdul Aziz Rashoud**		Ministry of Agriculture	Saudi Arabia
3	**Abdullah Bu Tuwaiba**		Ministry of Agriculture	Saudi Arabia
4	**Abdullah Dakheel**	Production and Management Systems Scientist	International Center for Biosaline Agriculture	UAE
5	**Abdulllah Salem Rashed Alessaei**	Senior Statistic Researcher	SCAD	UAE
6	**Abdulnasser Ali AlShamsi**	Principal Scientist	Ministry of Environment and Water	UAE
7	**Abdulrahim Abdullah**	Landscape Manager	MEYDAN	UAE
8	**Abdulrazzaq Ahmed Anwahi**	Senior Expert in Marine Environment	Ministry of Environment and Water	UAE
9	**Adel Al Hosani**	Director of Projects Department	Abu Dhabi Food Control Authority (ADFCA)	UAE
10	**Adnan Akber**	Director, Science & Technology Division, Water Research Center	Kuwait Institute for Scientific Research	Kuwait
11	**Ahmad Saif Al Muhiri**	Director of Public Parks & Horticulture Dept	Ajman Municipality	UAE
12	**Ahmed A AlSharif**	Deputy Director General	International Center for Biosaline Agriculture	UAE
13	**Ahmed Al Shuha**	Technical Director	CORODEX	UAE

No	Name	Job Title	Organization	Country
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15	**Alberto Del Lungo**	Forestry officer	Food and Agriculture Organization (FAO)	Italy
16	**Ali Harun Ozdikis**	Deputy Consul General	Consulate General of Turkey	UAE
17	**Ali Hassan Al Marzouqi**	Planning & Development Director	Abu Dhabi Food Control Authority (ADFCA)	UAE
18	**Ali Mahmoud El Sharrouf**	Researcher Water and Irrigation Management	Abu Dhabi Food Control Authority (ADFCA)	UAE
19	**Amer Salman**	Water Economist	University of Jordan	Jordan
20	**Anas Mohammed Kwider**	Head of control & Monitoring Unit	Al Ain Municipality	UAE
21	**Arash Nejatian**	Activities Coordinator Officer - Arabian Peninsula Regional (APRP)	Internation Center for Agriculture Research in the Dry Areas (ICARDA)	UAE
22	**Arfan Huseino**	Mechanical Engineer, Area Manager	CORODEX	UAE
23	**Ayesha Mohamed Al Khazraji**	Agri Planning & Economic Unitn Head	ADFSC	UAE
24	**Azaiez Ouled Belgacem**	Rangeland and Forage Scientist - Arabian Peninsula Regional (APRP)	International Center for Agrucultural Research in the Dry Areas (ICARDA)	UAE
25	**Basel Alyousifi**	Director, Regional Center for Environmental Health Action	Eastern Mediterranean Regional Office, World Health Organization	Jordan
26	**Berhanu Degefa**	Socio-eonomics Scientist	International Center for Biosaline Agriculture	UAE
27	**Boutheina Regaya**	Vice - Consul of Tunisia	Tunisian Conculate	UAE
28	**Dionyssia Aggeliki Lyra**	Post Doctoral Fellow	International Center for Biosaline Agriculture	UAE
29	**Ebrahim Hasan Ibrahim Al Hosani**	System Performance Engineer	Abu Dhabi Distribution Company (ADDC)	UAE
30	**Eng Abdul Razzaq Ahmed AlHammadi**	Head of STW and Lab	Sharjah Municipality	UAE
31	**Fahed Al Moamar**		Ministry of Agriculture	Saudi Arabia
32	**Fares Howari**	Prof and Director	ADU	UAE
33	**Farid Ahmad Mejwer**	Minister	Ministry of Agriculture and Irrigation	Yemen
34	**Fatma Ajeel Al Shamsi**	Treatment Operation Engineer	JSTP	UAE
35	**Fawzi AlSultan**	Chiarman, BoD	International Center for Biosaline Agriculture	UAE
36	**Fawzi Karajeh**	Principal Scientist, Integrated Water and Land Management Program	International Center for Agrucultural Research in the Dry Areas (ICARDA)	Egypt
37	**Fiona Chandler**	Director International Cooperations and	International Center for Biosaline Agriculture	UAE

No	Name	Job Title	Organization	Country
		Partnerships		
38	**Ghareeb Obaid Al-Mutawa**	Director of the Central Region	Ministry of Environment and Water	UAE
39	**Hadi Al Shabbihi**	Irrigation Specialist	Agricultural Research and Extension Authority (AREA)	Yemen
40	**Hamed Assaf**	Visiting professor	American University of Sharjah	UAE
41	**Hamoud Darwish Salim Al-Hasni**	Assit. Director General	Directorate General of Agriculture and Livestock Research	Oman
42	**Hanaa Khalifa Jumaa**	Researcher in Environment	Ministry of Environment and Water	UAE
43	**Hassan Al Sayed Mazen**	Senior Engineer	Ministry of of Water Resources and Irrigation	Egypt
44	**Hassib Amami**	Resercher	National Research Institute for Rural Engineering, Water and Forestry	Tunisia
45	**Henda Mahmoudi**	Biotechnologist	International Center for Biosaline Agriculture	UAE
46	**Hind Rashed Saeed Bin Hussien**	Manager of Health, Safety and Environment Dept	Federal Electricity and Water Authority (FEWA)	UAE
47	**Hossam ElShahawi**	Agricultural Engineer	Ministry of Environment and Water	UAE
48	**Husni Jasser Muhammad**	Ground Water Specialist - Environment Control Section, Environment Dept	Dubai Municipality	UAE
49	**Ibrahim Al Zarouni**	Head of Section of Agriculture	Ajman Municipality	UAE
50	**Inas Abdul Azeem Mustafa**		League of Arab States	Egypt
51	**Ishaq Al Ruqaishi**	Advisor	Ministry of Agriculture & Fisheries	Oman
52	**Ismahane Elouafi**	Director General	International Center for Biosaline Agriculture	UAE
53	**Jalal Jalouli**	General Manager	SIYANA	UAE
54	**Janine Tan**	Assistant Professor	Zayed University	UAE
55	**Javier Mateo-Sagasta**	Senior Scientist	International Water Management Institute	Sri Lanka
56	**Jawaher Hamad Saeed**	CiviL Engineer	Federal Electricity and Water Authority (FEWA)	UAE
57	**Kevin Paul**	Environmental Consultant	Green Consulting	UAE
58	**Khalil Jamjoum**	Director of interior unit at NCARE	National Center for Agricultural Research and Extension NCARE	Jordan
59	**Liqa Raschid Sally**	Senior Scientist	International Water Management Institute	Sri Lanka
60	**Maha Salem Al Derei**	Researcher Marginal Water	Abu Dhabi Food Control Authority (ADFCA)	UAE
61	**Mahmoud Ali Abdelfattah**	Manager Soil Quality Section	Environment Agency - Abu Dhabi	UAE

No	Name	Job Title	Organization	Country
62	**Manar Yazbeck**		UN / UNDP	UAE
63	**Manhal Alzoubi**	Resercher	General Commission for Scientific Agricultural Research (GCSAR)	Syria
64	**Mansour Al-Aqil**	Director General	Agricultural Research and Extension Authority (AREA)	Yemen
65	**Mazen Almalkawi**	Environmental Engineer	Eastern Mediterranean Regional Office, World Health Organization	Jordan
66	**Michael Stenzel**	Managining Director	SIYANA	UAE
67	**Mohamad Ben Abdullah**	Director General	National Research Institute for Rural Engineering, Water and Forestry	Tunisia
68	**Mohamed Al Mulla**	Director of Water Resources Dept	Ministry of Environment and Water	UAE
69	**Mohamed Hachicha**	Senior Researcher	National Research Institute for Rural Engineering, Water and Forestry	Tunisia
70	**Mohammad Al Rifaee**	Principal Agricultural Researcher	National Center for Agricultural Research and Extension NCARE	Jordan
71	**Mohammad Dawod**	Water Resources Advisor	Environment Agency - Abu Dhabi	UAE
72	**Mohammed Abdallah Jitan**	Water Management Expert	MOEW	UAE
73	**Mohammed Al-Rawahi**	Environmental Specialist	BAUER Nimr LLC	Oman
74	**Mohammed Mousa Abdallah**	Director of Agriculture Research	Ministry of Environment and Water	UAE
75	**Monia Trad**	Resercher	National Research Institute for Rural Engineering, Water and Forestry	Tunisia
76	**Mr Abdoulaye Gueye**	First Counsellor	Embassy of Senegal in Abu Dhabi	UAE
77	**Mr Said Ali Shah**	Head of Compost Plant	Sharjah Municipality	UAE
78	**Mubarak Almansouri**	Executive Director of Agriculture Sector	Abu Dhabi Food Control Authority (ADFCA)	UAE
79	**Muhammad Akhtar Bhatti**	Land and Water Officer	FAO SNG, Abu Dhabi	UAE
80	**Munawwar Ali Khan**	Associate Professor	Zayed University	UAE
81	**Murad Al Shuwaikh**		Islamic Development Bank	Saudi Arabia
82	**Mushtaque Ahmad**	Associate Professor	Dept. of Soils, Water & Agricultural Engineering, College of Agricultural & Marine Sciences, Sultan Qaboos University	Oman
83	**Nabil Beni-Hani**	Director of Regional Center of Agricultural Research and Extension of Deir Alla Irrigation and Soil Researcher	National Center for Agricultural Research and Extension NCARE	Jordan
84	**Nada Alsuwaidi**		Ministry of Environment and Water	UAE
85	**Naif AlShammari**		King Abdulaziz City for Science and Technology	Saudi Arabia

No	Name	Job Title	Organization	Country
86	**Nida Qafisheh**	Assistant Professor of Environmental Science	ADU	UAE
87	**Noora Karam Jalal**	Director - East Region - Fujairah	Ministry of Environment and Water	UAE
88	**Nurul Akhand**	Irrigation Management Scientist	International Center for Biosaline Agriculture	UAE
89	**Omar Jouzdan**	Expert in soil and water uses	Arab Center for the Study of Arid Zones and Dry Lands (ACSAD)	Syria
90	**Osman Elmi**	International Consultant		UAE
91	**Peter Burt**	Business Development Manager	New Zealand	UAE
92	**Peter Ensor**	Section Manager, Planning & Studies	ADFSC	UAE
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97	**Said Bin Khamis Al Maslahi**	Director Treated Wastewater and Fertilizers Dep	Haya Company	Oman
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100	**Salem Mohammed Saeed Alameri**	Maintenance Planning Engineer	Abu Dhabi Distribution Company (ADDC)	UAE
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104	**Shoaib Ismail**	Acting Director Research and Innovations	International Center for Biosaline Agriculture	UAE
105	**Simon Walster**	Water Strategy Manager	RSB	UAE
106	**Slim Zekri**	Associate Professor	Department of Natural Resource Economics, College of Agricultural & Marine Sciences, Sultan Qaboos University	Oman
107	**Steven Schonberger**	Sector Manager for Water and Agriculture, Middle East and North Africa Region	World Bank	USA
108	**Susan F Kilani**	Advisor	Ministry of Water and Irrigation	Jordan
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111	**Tariq Dafaallah Adam**	Deputy Economic Council	Sudan Embassy	UAE
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113	**Xavier Mathieu**	Capital Investment and Performance Manager	ASPCL	UAE
114	**Yaser Omar Hafeth Kayed**	Head of Studies & Planning Unit	Ajman Municipality	UAE
115	**Yasmin Hassan Teima**		League of Arab States	Egypt
116	**Yusri Al Yaarubi**	Senior Engineer	Abu Dhabi Distribution Company (ADDC)	UAE

ANNEX 3 PRESENTATIONS PRESENTED

Global perspectives on TWW Resources and use in Agriculture, Javier: Presented the status of WW and TWW reuse both direct reuse and indirect reuse and future directions. Outlined the differences between formal and informal reuse of water. Gave an overview of the major hazards associated with WW.

Global perspectives in the use of TWW Resources in Agriculture production, Liqa Raschid Sally: Gave an overview of the challenges facing reuse of TWW and the three cornerstones for safe reuse. Presented the results of various studies examining public perceptions towards TWW reuse and discussed the importance of getting stakeholder buy-in. Presented the lessons learned on facilitating Multi-stakeholder platforms.

Current Status of TWW Resources in the Arab World and their use in Agricultural Production, Omar Jouzdan: Presented the status of the water and wastewater situation in the MENA Region. Outlined the benefits and hazards of using TWW for agricultural production. Presented ASCAD Program of sustainable management of land and water uses and various projects implemented.

Potential for use of TWW Resources in GCC countries, Alberto Del Lungo & Muhammad Akhtar Bhatti: Presented the water resources in the MENA region, the characteristics of the areas especially in regards to forests and rangeland. He presented alternative non-conventional waters available that the region can pursue, plus the different health risks associated with different crops and irrigation systems. Then the potential of using TWW in the GCC and a few case studies.

TWW Technology and Use: Experiences from the Gulf Region, Said Al-Muslehi: Presented Heya Water responsible managing Muscat's wastewater. It covered the current and future infrastructure plan and the various water reuse system components. The company currently treats the WW and sells the treated effluent and sludge.

Experiences and achievements of the Kingdom of Saudi Arabia in the Use of TWW in Agricultural Production, Abdul Aziz Rashoud AlRashoud & Abdullah Bu Tuaiba: Presented the water situation in Saudi Arabia, and the country's wastewater sector. The presentation covered the different current, planned and recommended WWT plants and reuse schemes in the various governorates.

TWW resources and current and future utilization in Abu Dhabi, Mohammad Abdul Hameed Dawod: Gave an overview of the wastewater sector in Abu Dhabi, current experience in TWW reuse plus the potential future uses the Emirate is currently considering. Presented the challenges facing wastewater reuse and strategies to overcome them.

Research and successful interventions to increase efficiency and effectiveness of TWW reuse in agriculture in Morocco, Redoune Choukr-Allah: Gave an overview of the water sector in Morocco, with a special focus on WW treatment and reuse. Presented specific WW reuse case studies from Morocco and lessons learned.

Tunisia experience in the use of TWW in agriculture: highlands and lessons learned, Mohamed Hachicha: Presented the challenges, treatment, and use of TWW in Tunisia. It presented the policies and institutions involved in TWW, plus the research carried and the lessons learned from over 30 years of reuse in the country.

Forage production using TWW in Jordan: achievements and aspirations, Mohamed Al-Riafee: Gave an overview of the water situation and forage production in Jordan. It presented

Jordan's research and achievements with TWW reuse as well as the country's future plans and aspirations.

Impact of the use of TWW in Agriculture Production in Syria, Mohamed Al-Zoubi: Gave an overview of the use of TWW in agricultural production in Syria. Presented the research and projects they have implemented on the use of WW, TWW and WW sludge in agricultural production, together with the results achieved.

Guidelines and standards in the use of TWW: new directions, Basel Al-Yousfi & Eng. Mazen Al-Malkawi: Outlined the global WW generation, treatment and reuse, plus the risks of using WW. Summarized the history of WHO WW Guidelines starting with the 1st edition issued in 1973 up till the latest WHO guidelines of 2006, listing the driving factors for developing and updating the guidelines throughout the years.

Strategies to Augment agricultural water shortages: case studies of grey - and TWW from Jordan and Egypt, Fawzi Karajeh: Gave an overview of the challenges facing the Arab region, focusing on the impact of climate change. Presented the overall challenges facing the agricultural sector in the MENA region and the role TWW can play. The presentation then went on to give a case study of Grey Water reuse in Jordan, and the Egypt case study in using TWW as a strategy for pollution control and halting salt water intrusion.

Strategic Priorities of the use of TWW resources in the United Arab Emirates, Mohammad Al-Mulla: Gave an overview of the water sector in the UAE and the challenges they face; presented the water budget and the importance of IWRM to ensure sustainable uses of water resources an safeguard available resources.

Utilization of TWW Resources in Egypt, Mohamed Al-Zoubi: Gave an overview of the use of TWW in Egypt. Presented the policies and guidelines governing TWW reuse for agriculture production in Egypt, types of WW treatment available in Egypt, and the various reuse happening in the country.

TWW irrigation in crop production in Oman: Highlands and lessons learned, Saif Al Khamisi: Gave an overview of the research carried in Oman on the use of TWW in Oman. Presented the results of the research and projects undertaken as well as the lessons learned.

The use of treated sewage water for afforestation, desertification control and biofuel crop production in Egypt, Raafat Khidr: Gave an overview current demographic imbalance in areas of Egypt along with the resulting water shortage. Presented reforestation projects implemented in the country.

Storing TWW underground and its' use for growing crops: a case study from Oman, Mushtaque Ahmed: Presentation outlined the mechanism and benefits of storing TWW in groundwater reservoirs. Gave an overview of case studies implemented in various countries and summarized Oman's on-going and planned projects in this field.

Artificial recharge by TWW in Oued Souhil - Nabeul area: effect on soil and groundwater characteristics, Mohamed Hachicha: Presented the case study of artificially recharging the Aquifer in Oud Souhil. Covered the techniques used as well as the results achieved and effects noticed.

The importance of heavy metal elements in environmental pollution and danger to Human Health, Omar Jouzdan: Presented the difference between biological pollution and chemical pollution and the danger they pose. Covered the main dangerous heavy metals that must be monitored. Presentation also gave a overview of a detailed analysis carried in Syria and Tunisia on the impact on the crops irrigated with WW and TWW over long periods of time.

Use of tertiary TWW in irrigation activities: a case studies from Kuwait, Adnan Akber: Gave an overview of the water resources of Kuwait: production, water uses, wastewater treatment. Presented Kuwait's study for replacing freshwater used in agriculture with TWW; specifically the Soil Aquifer Treatment (SAT) process.

Impact of TWW on soil and plant constituents: highlights of research from Oman, Saif Alkhamisi: Presented the impact of reusing TWW on the crops irrigated with this water as well as the effect on the soil. In addition, an overview of three separate studies carried in areas irrigated with TWW.

Impact of TWW irrigation on soil environment: a case study of Jordan, Khalil Jamjoum: Presented the results of the analysis carried on the crops and soil of land irrigated with TWW from the Ramtha WWT plant.

Irrigation of citrus orchards with treated wastewater in Northern Tunisia: effects on microbiological quality of soil and fruits, Monia Trad Rais: Gave an overview of the detailed study carried in Tunisia (2011-2012) which analyzed the WWT available in Tunisia and the effects on soil and fruit of irrigating with secondary TWW. Analysis was based on the analysis of 2 plots: Control plot irrigated with fresh water, and experimental plot irrigated with TWW.

Health aspects of reuse of TWW under different methods of irrigation, Nabeel Bani Hani: Gave an overview of the WWT plants in Jordan and the current treatment levels. Also presented international studies carried that examined the different health aspects of reuse of TWW.

Assessment of Pathogens and Heavy Metals Contamination in Vegetables Grown with Treated wastewater in Vegetables Grown in the UAE, Nurul Akhand: Presented highlights of research carried at ICBA on the use of TWW, from Dubai treatment plant,in production of vegetable crops, particularly the heavy metals and pathogens presence and the impact of different irrigation methods (subsurface drip and surface drip) on production and concentration of nutrients and heavy metals.

An Economic Framework for WW Irrigation, Javier Mateo-Sagasta: Gave an overview of the benefits and cost of TWW reuse, as well as the financial impacts. Introduced the different aspects of carrying a cost-benefit analysis, and presented the case study of the Llobregat Delta in Spain

The social acceptability and economic analysis of TWW use in agriculture: a Tunisian case study, Hacib El Amami: Presented the study carried in four areas in Tunisia located in different climatic zones and different cropping patterns, to assess farmers attitudes towards TWW, crops grown, and impact. Outlined the findings and results.

Assessing the impact of using TWW and fresh water on the socio-economics of farmers in the Jordan Valley, Amer Salman: Presented the economic analysis carried to analyze the impact of using TWW for irrigation in the Jordan Valley. The analysis compares the use and impact of using fresh water and blended TWW.

Economic and social aspects of TWW: a case of Oman, Slim Zekri: Presented the economic analysis carried to analyze the economic feasibility of the use of TWW in Oman, and when this use is profitable.

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