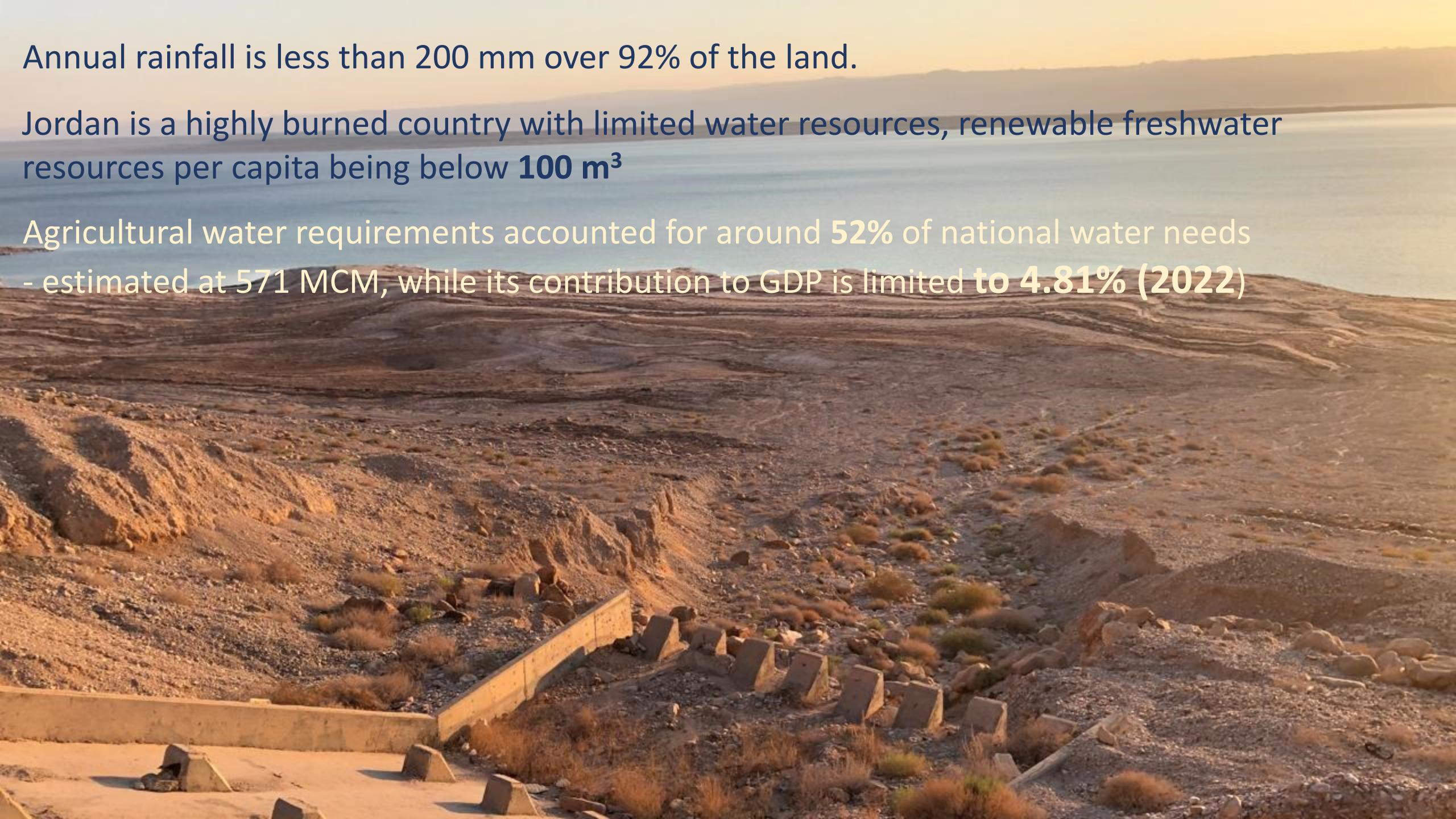
SANITATION SAFETY PLANNING

MANUAL FOR SAFE USE AND DISPOSAL OF WASTEWATER, GREYWATER AND EXCRETA

Case study from Jordan

Ghada Kassab, PhD



Annual rainfall is less than 200 mm over 92% of the land.

Jordan is a highly burned country with limited water resources, renewable freshwater resources per capita being below **100 m^3**

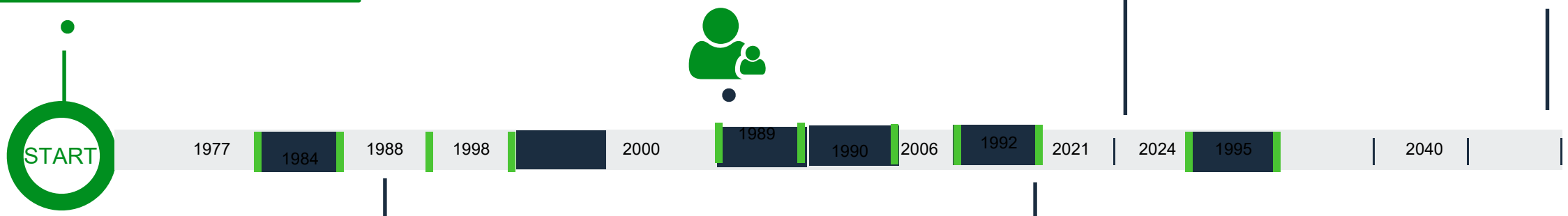
Agricultural water requirements accounted for around **52%** of national water needs - estimated at 571 MCM, while its contribution to GDP is limited **to 4.81% (2022**)

National Water Strategy 2023- 2040

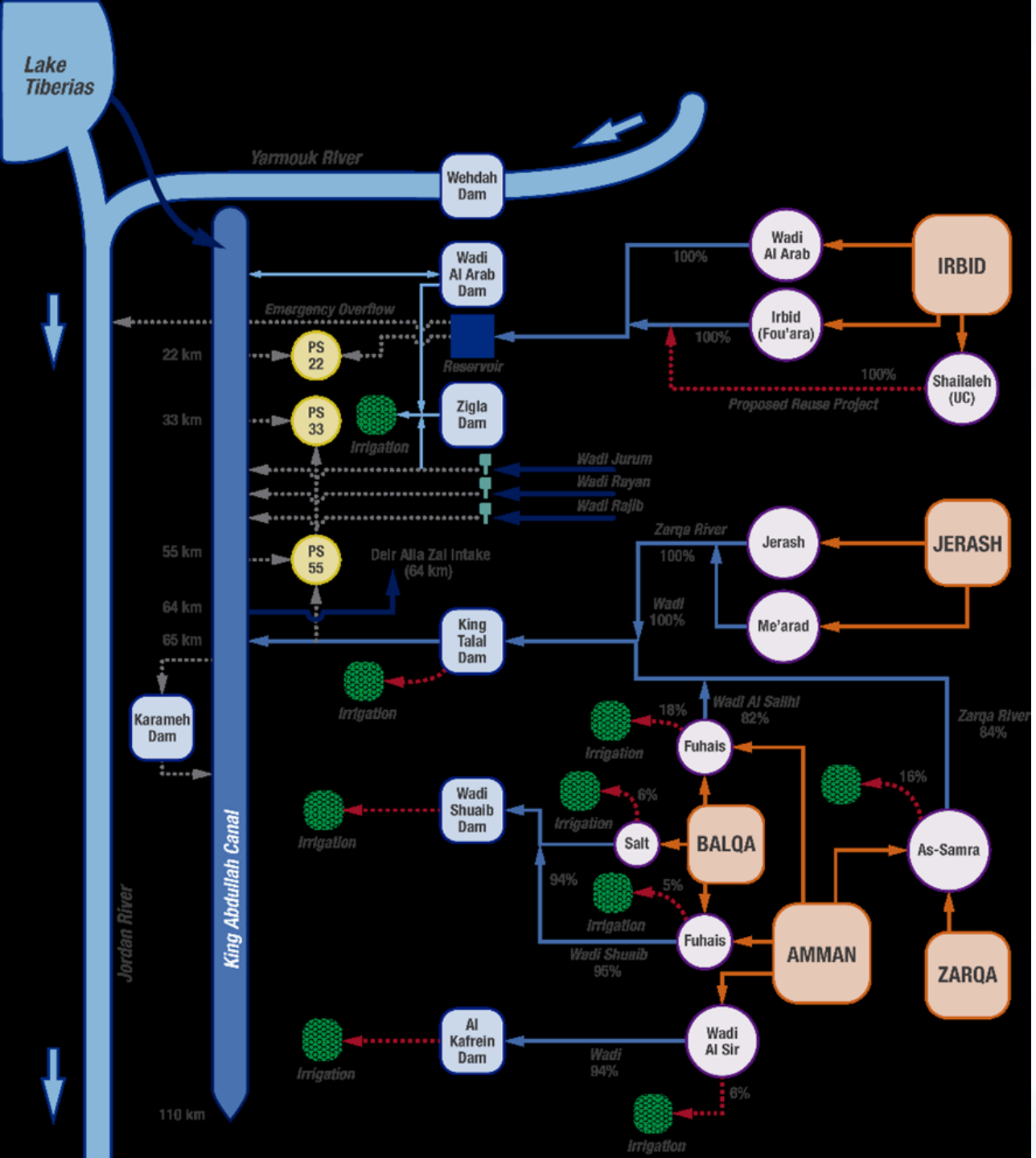
Expanding sanitation services from 66% (2021) to 80% (2040)

Increase reclaimed water use for agriculture and industry

Since 1977, the Jordanian government has officially promoted agricultural wastewater use



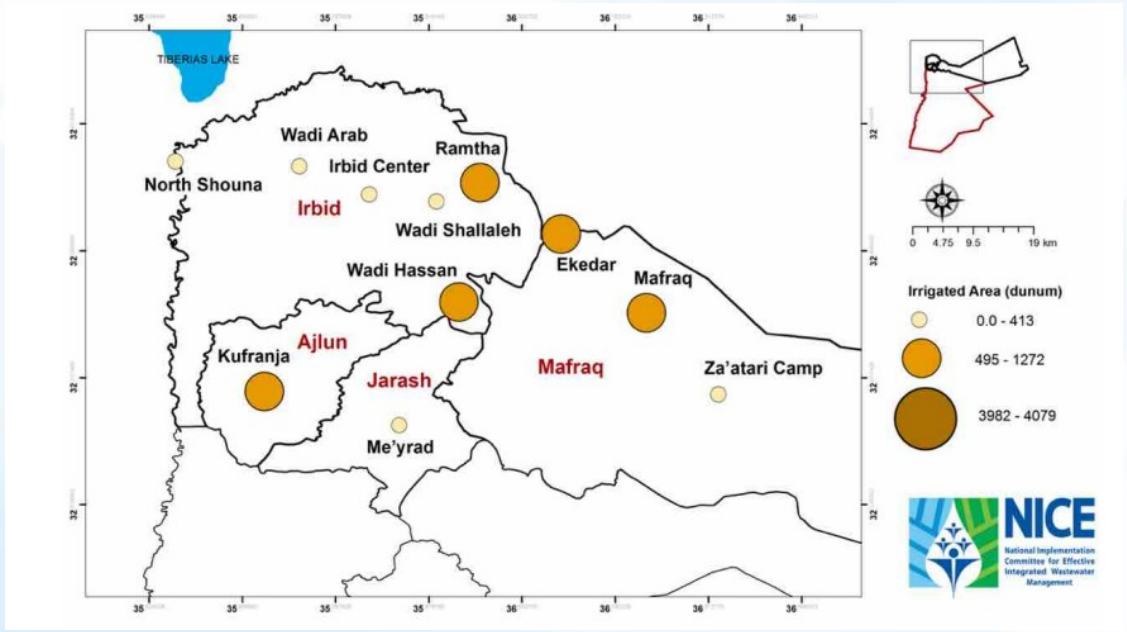
In 2021, Treated wastewater reached **186 MCM**, Of which **90%** are reused directly and indirectly, accounting for about **28.6%** of the total amount of water used for irrigation.

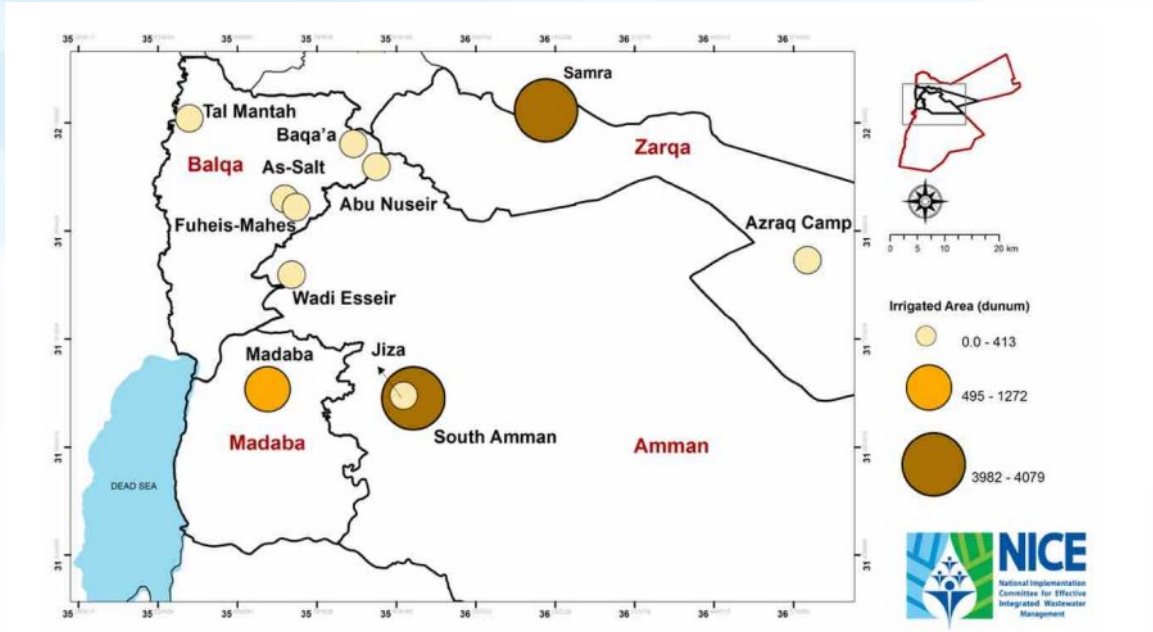


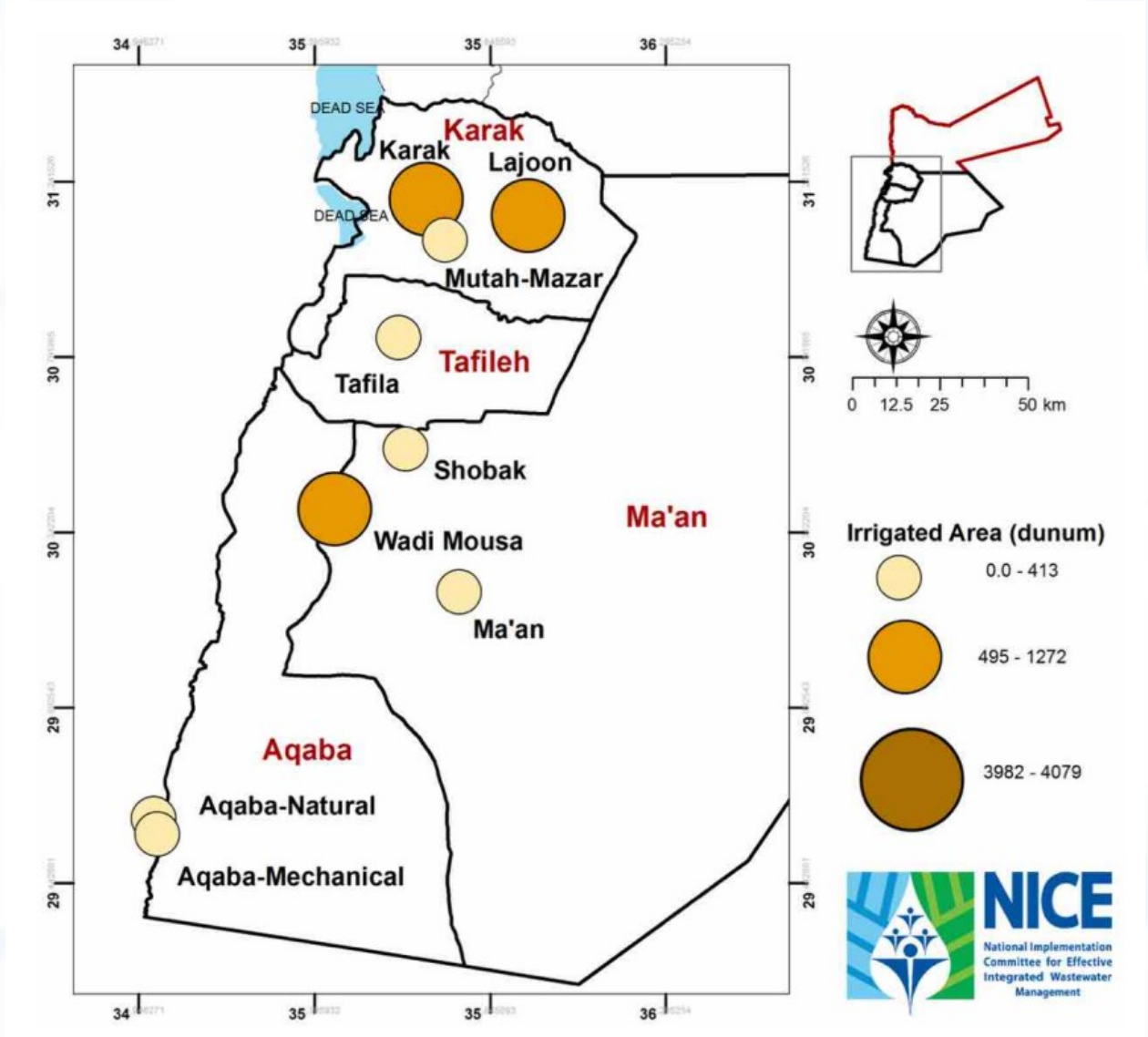
(Indirect reuse)

130 MCM of Kherbit As-Samra WWTP, is discharged to Seil Al Zarqa, flows to King Talal dam, and from there to King Abdullah Kanal, where it is used for agricultural irrigation in the Jordan Valley.

Direct Reuse







Total area of land irrigated with treated wastewater from centralized wastewater treatment plants

The Sanitation Safety Planning

Risk based management tool to for sanitation system

Protection of public and occupational health; from source to end use.

Quality assurance and safety of end products, workers, local communities and consumers of the product

Social and cultural reservations on the reuse of treated wastewater

Inability to update the current regulations

Enhance cost effectiveness of agricultural wastewater use

Social and cultural reservations on the reuse of treated wastewater

Reduces health risks to consumers, workers and local communities

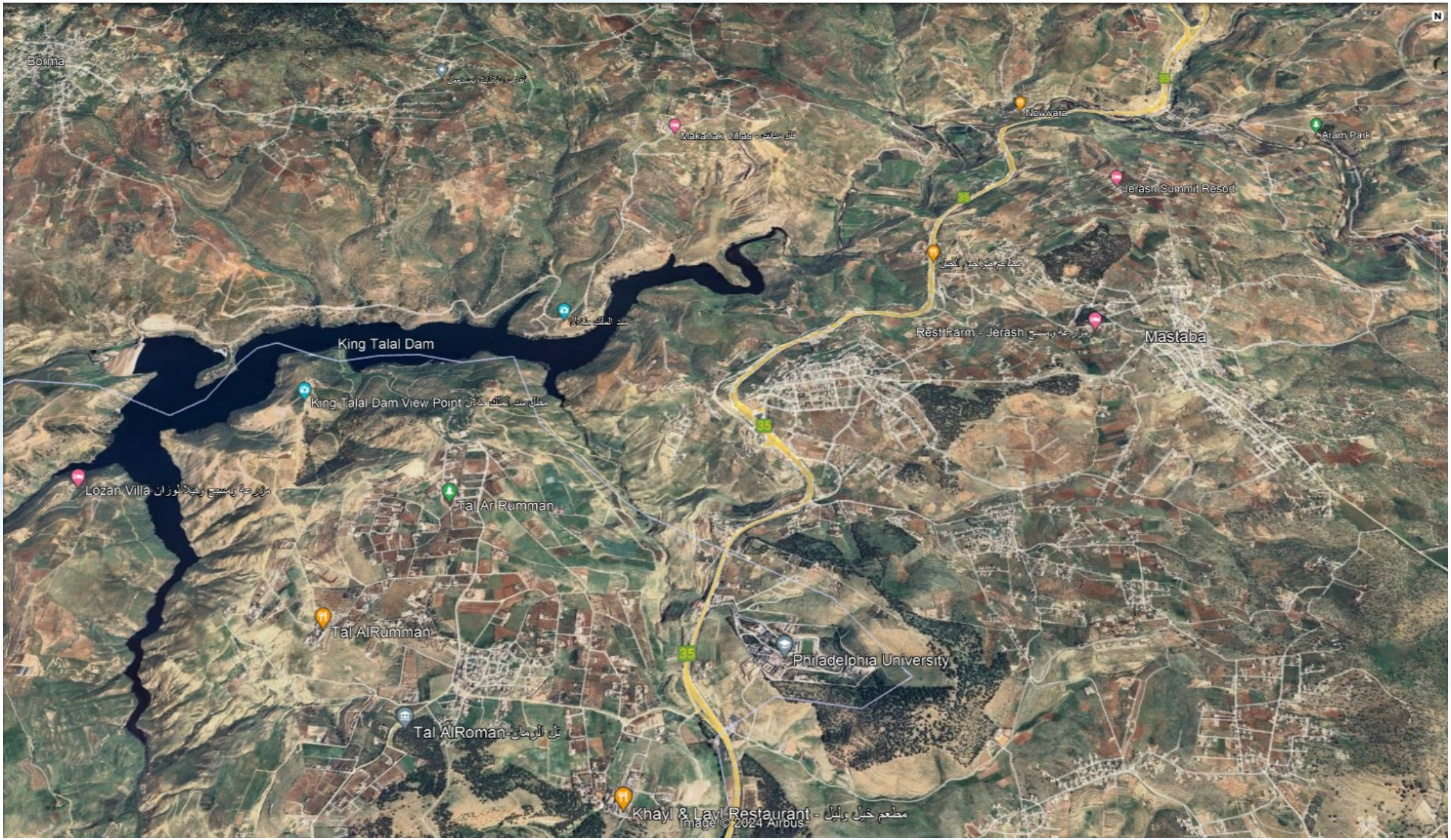
Inability to update the current regulations needed to limit freshwater usage and expand reuse

promote the adoption of the concept of health based target in the practices of agricultural wastewater use

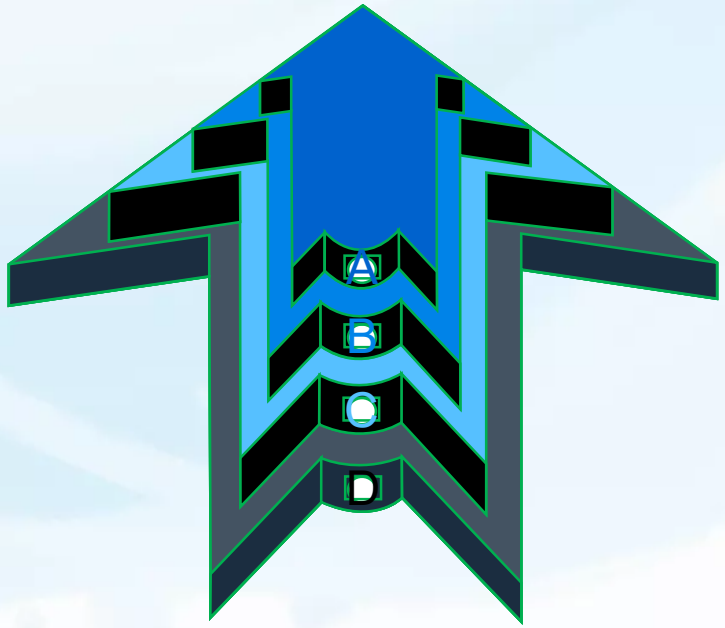
The 2006 WHO guidelines for the safe use of wastewater, excreta and grey water (WHO, 2006)

PREPARE FOR SANITATION SAFETY PLANNING


Al Khirbah As Samra
Graisa
Al-Birah
VEGAS FARM
Umm Sleih
MAFRAQ GOVERNORATE
Zarqa River
Zarqa River
Zarqa River
Al Hashemiya
Ar-Ruhayl
As-Sukhnah
Jordan Petroleum Refinery AlZarqaa
Abu-Al-Zighan
MA'AMEL AL TOOB
AL BUSTAN
AL HASHIMEIYAH AL JANOBIYAH
Image © 2024 Airbus
Google Earth
1985
Imagery Date: 5/6/2023 32°08'27.28" N 36°05'03.41" E elev 1666 ft eye alt 43419 ft


Borma
Nemwaia
Aram Park
Jerash Summit Resort
35
King Talal Dam
Rest Farm - Jerash
Mastaba
King Talal Dam View Point
Lozan Villa
Tal Ar Rumman
Tal AlRumman
Philadelphia University
Tal AlRoman
Khayl & Layl Restaurant
Image © 2024 Airbus

1.2 Assemble the SSP team



A Establishment of a steering committee

B Form the SSP team

C Define and record the roles of the individuals on the team

D Appoint an SSP team leader

Stakeholder identification and analysis

(*i*) Identifying stakeholders;

(*ii*) Differentiating between and categorizing stakeholders; and

(*iii*) Investigating relationships between stakeholders.

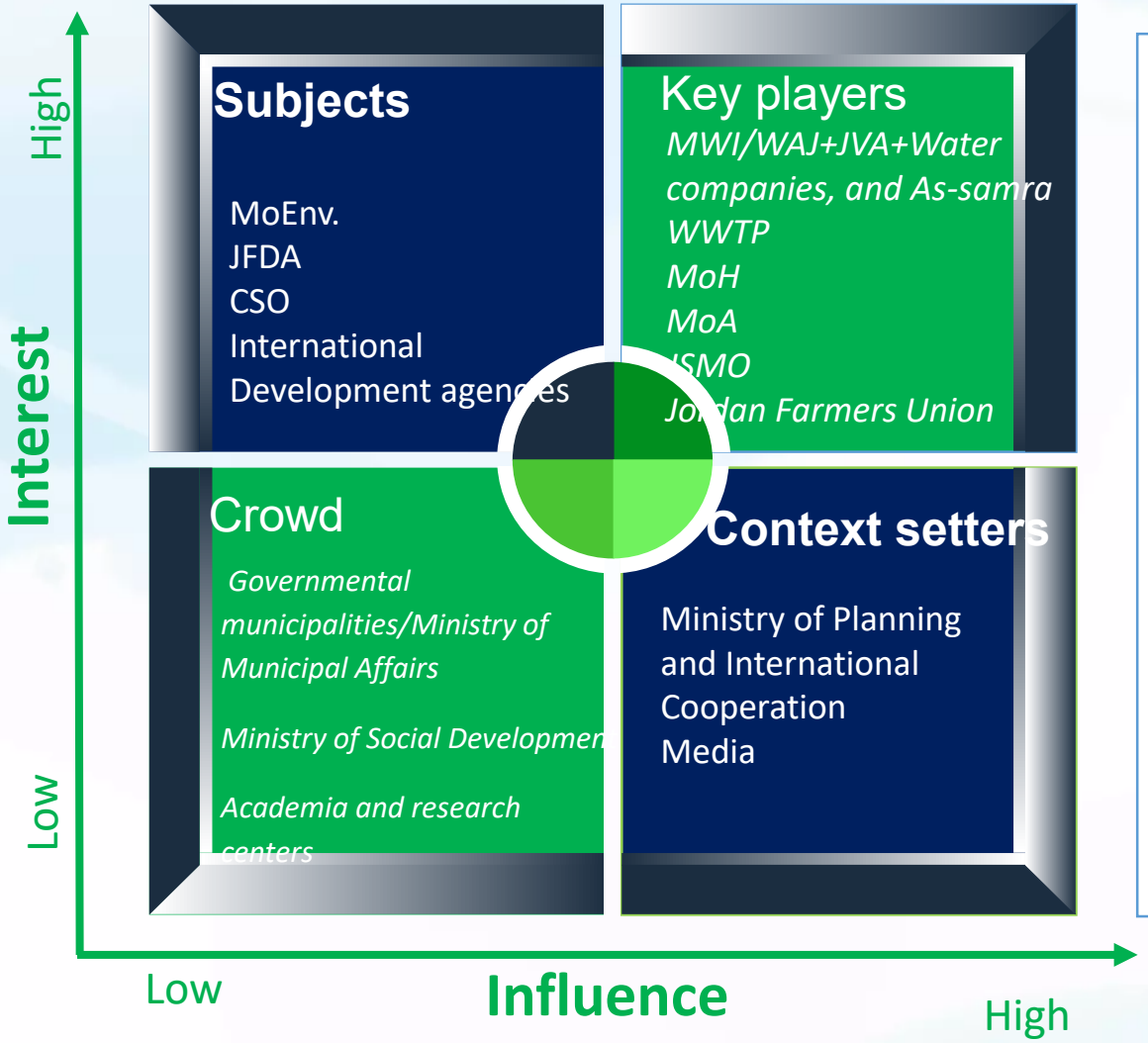
Stakeholders: Any group or individual who can affect or is affected by a decision or action taken by decision makers (Freeman, 2010).

Start with the listing of agencies and individuals that are agreed upon as actors who have stakes in the matter sanitation.

Primary Stakeholders	Role and responsibility
1. Farmers; Water Users Associations Jordan Farmers Union Big farmers	• Augmentation of irrigation water resources • Improvement of irrigation water quality • Enhance marketability • Enhance economic feasibility/nutrient content
2. Ministry of Water and Irrigation (MoWI) Water Authority of Jordan (WAJ) Jordan Valley Authority (JVA) Water Companies/ As samra WWTP	• Achievement of supply targets • Cost recovery from users • Public image • Policies development

Secondary Stakeholders	Role and responsibility
governmental organizations	
1. Ministry of Health (MoH)	• Reduce/eliminate incidents of diseases
2. Ministry of Agriculture (MoA)	• Achievement of irrigation water supply target, quantitatively and qualitatively • Improve water use efficiency at farm level • Enhance marketability • Extension and outreach
3. Ministry of Environment (MoEnv.)	• Prevent deterioration of environment. • Green growth
4. Jordan Food and Drug Administration	• Ensuring edible crops safety and quality
5. Jordan Standards and Metrology Organization (JSMO)	• Protection of human health and environment through development of systems and standards that ensure compliance with best management practices within the agricultural and water sectors.
6. Governmental municipalities/Ministry of Municipal Affairs.	• Improve living and environmental conditions for residents. • Increase green areas/landscaping • Public image and popularity.
7. Ministry of Social Development	• **Improve living and environmental conditions for residents** • **Gender mainstreaming**
8. Ministry of Planning and International Cooperation	• Economic planning • key contact for donor organizations in coordinating agreements with other ministries
9. Academia and research centers **National Center for Agricultural Research and Extension (NCARE)** **Royal Scientific Society (RSS)** **The Higher Council for Science and Technology (H.C.S.T)**	• Developing best management practices for agricultural use of reclaimed water. • Serves as a third party for inspection and monitoring within the water sector.
10. International development agencies **USAID** **GIZ** **kfw** **JICA**	• Provide technical and institutional support for attainment of sustainable and integrated water resources management.

After compiling a broad list of stakeholders, an analytical categorization of stakeholders should be conducted. Stakeholders must be classified based on levels of interest and influence (Lindenberg and Crobsy, 1981) into "Key players," "Context setters," "Subjects," and "Crowd." Such classification can help specify stakeholders' engagement.



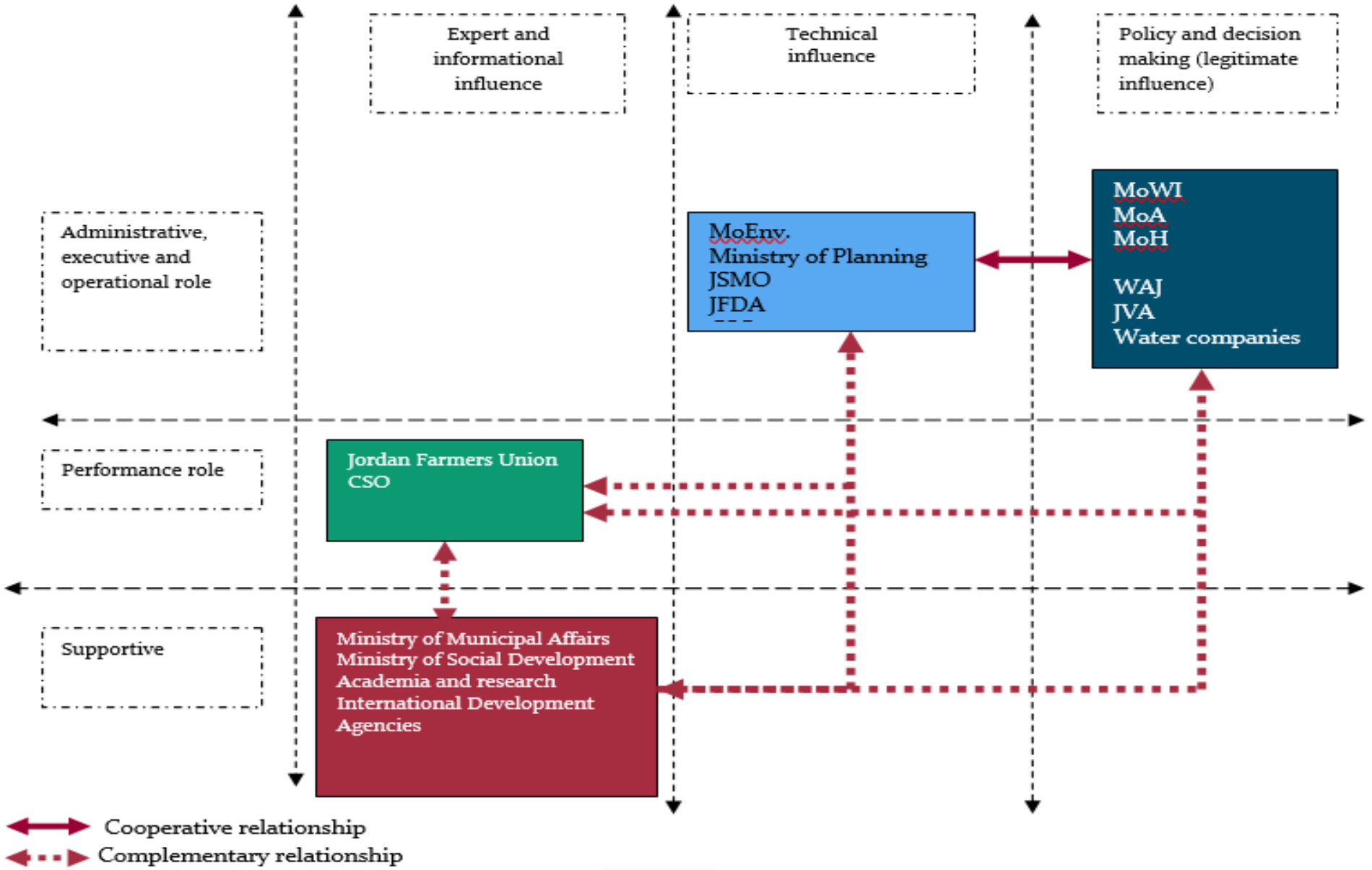
Key players are stakeholders who have a high interest in and influence. Accordingly, they should be persistently and actively engaged.

Context setters are those stakeholders who are highly influential but have low interest. As a consequence, they may pose risks, and they should be carefully managed.

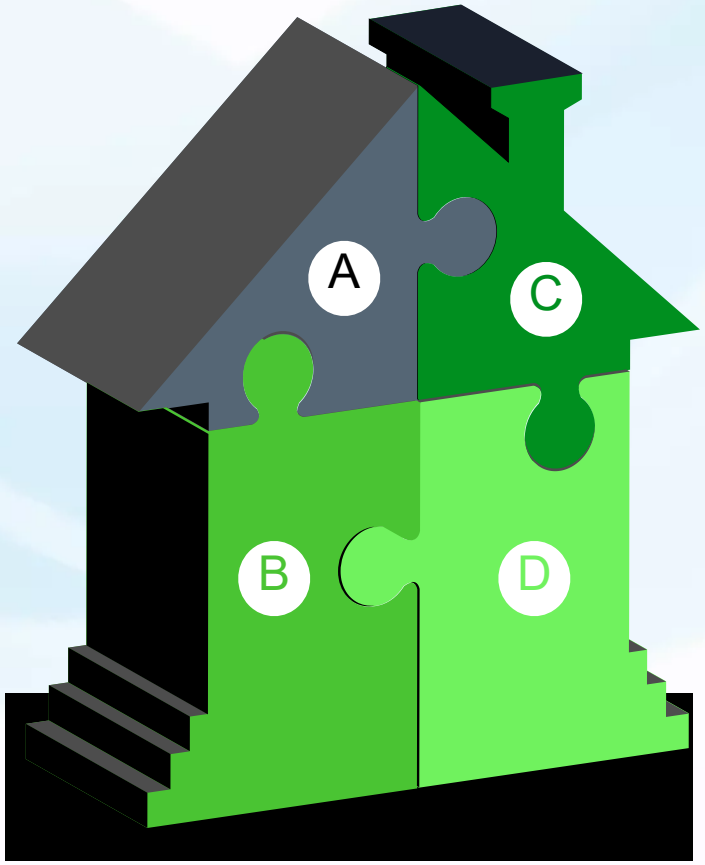
Subjects are stakeholders who have a high interest in and low influence. In other words, they need more tools and capabilities for impact.

The ***Crowds*** are stakeholders who have little interest in and influence. Hence, there isn't an urgent need for their consideration or engagement.

Matrix of stakeholders interrelationships

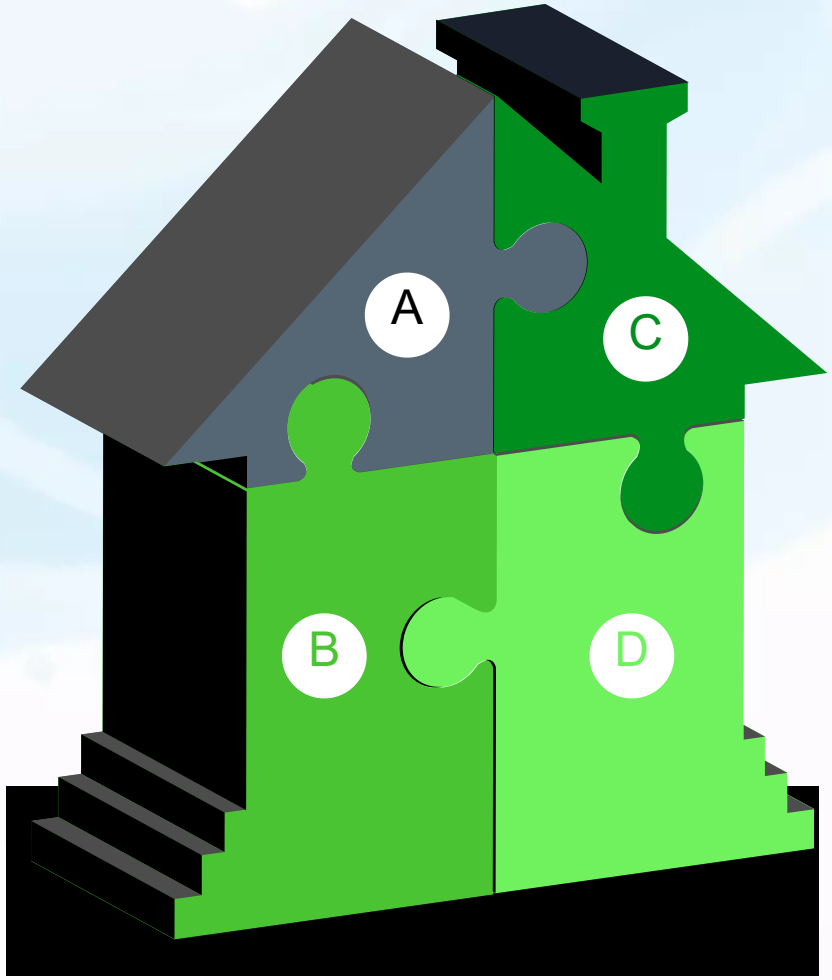


SSP team



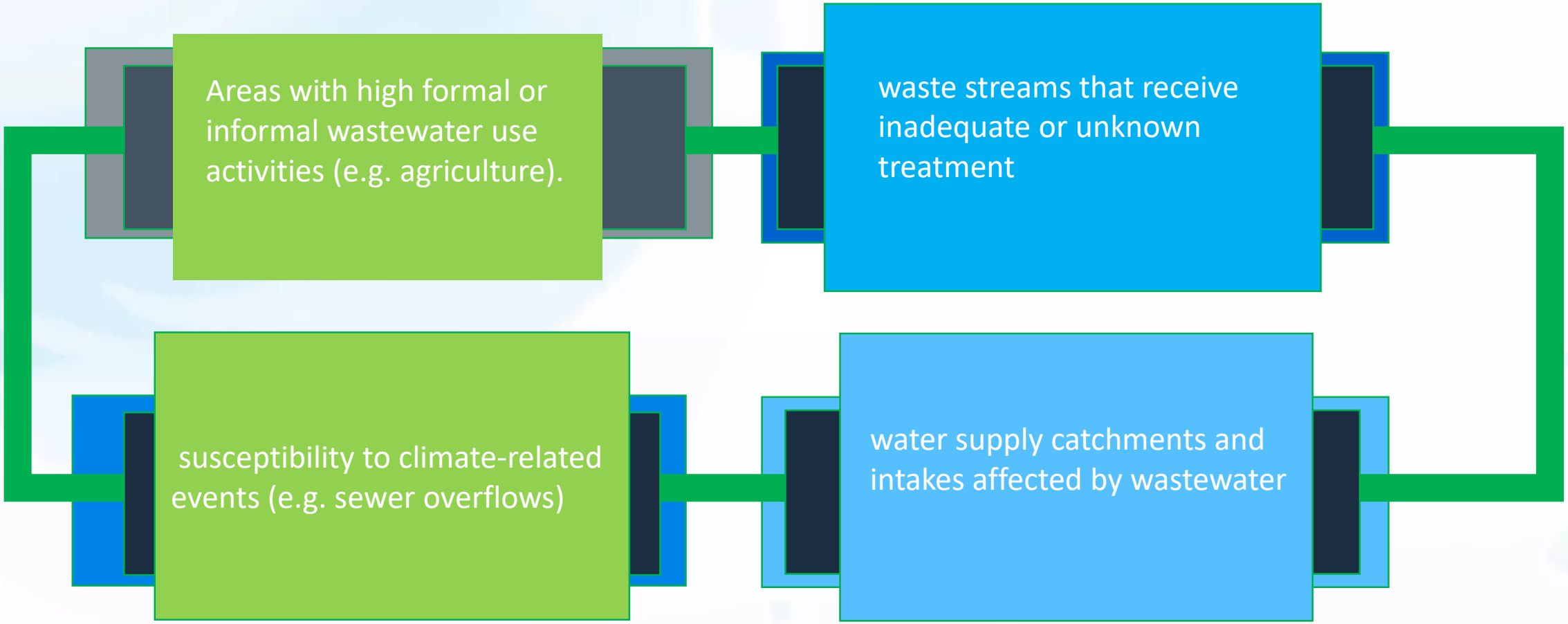
Team Leader/ Water Authority of Jordan representative-Studies department.
Assistant team leader/Water utilities- Water companies
Team Coordinator/ Water Authority of Jordan- Operation departments
WAJ rep. (collection, treatment and reuse
JVA rep.
Ministry of Health rep.
Ministry of Agriculture rep.
Ministry of Municipality rep.
JISM rep.

Steering committee



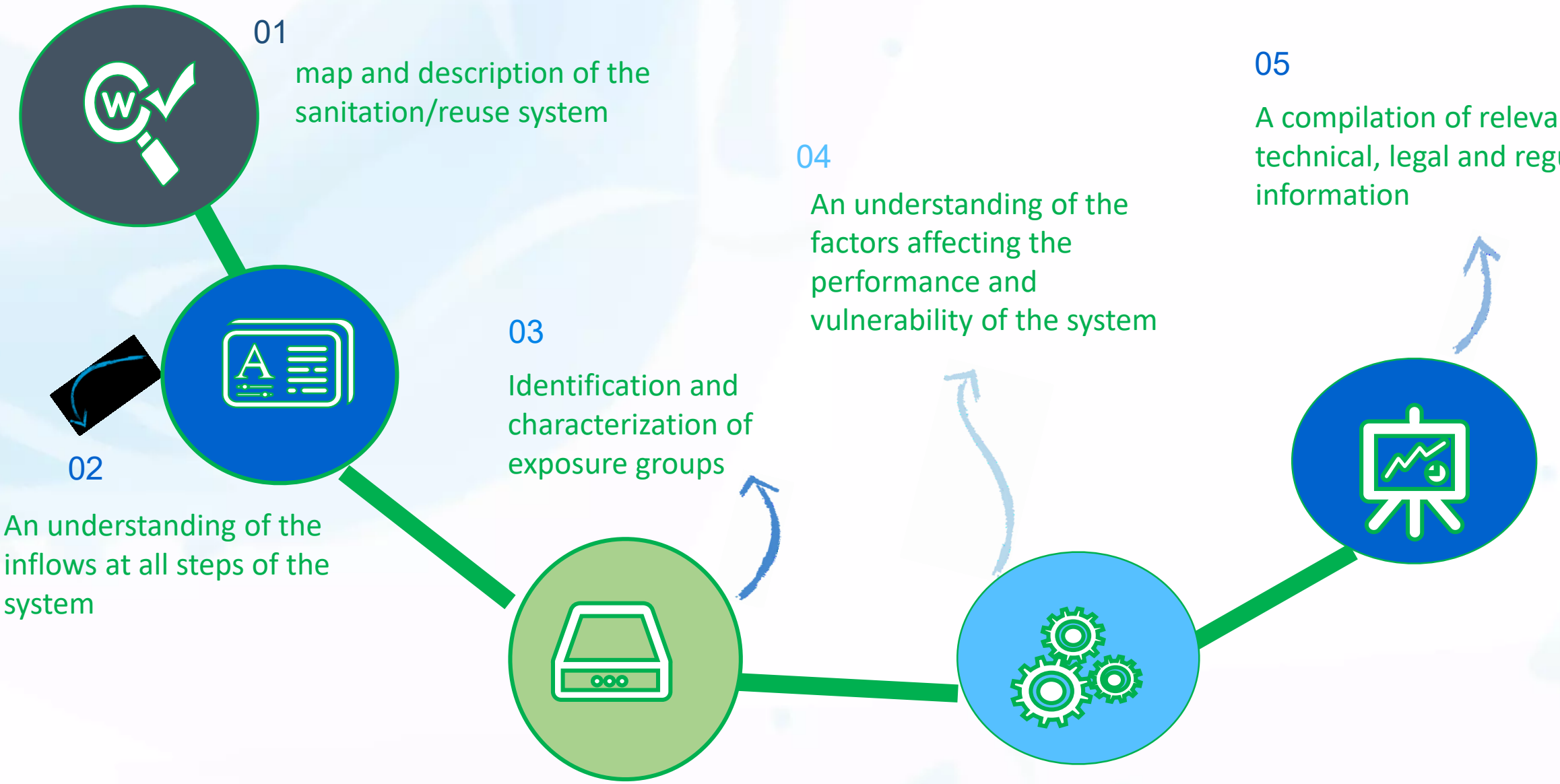
Water Authority
Water utilities/ Water companies
Ministry of Health
Ministry of Agriculture
Academia/ research centers
Related regulatory bodies/ Jordan Standards and Meteorology Organization
Jordan Food and Drug Association

1.3 Establishment of SSP priorities



DESCRIBE THE SANITATION SYSTEM

DESCRIBE THE SANITATION SYSTEM/Outputs



01

map and description of the sanitation/reuse system

02

An understanding of the inflows at all steps of the system

03

Identification and characterization of exposure groups

04

An understanding of the factors affecting the performance and vulnerability of the system

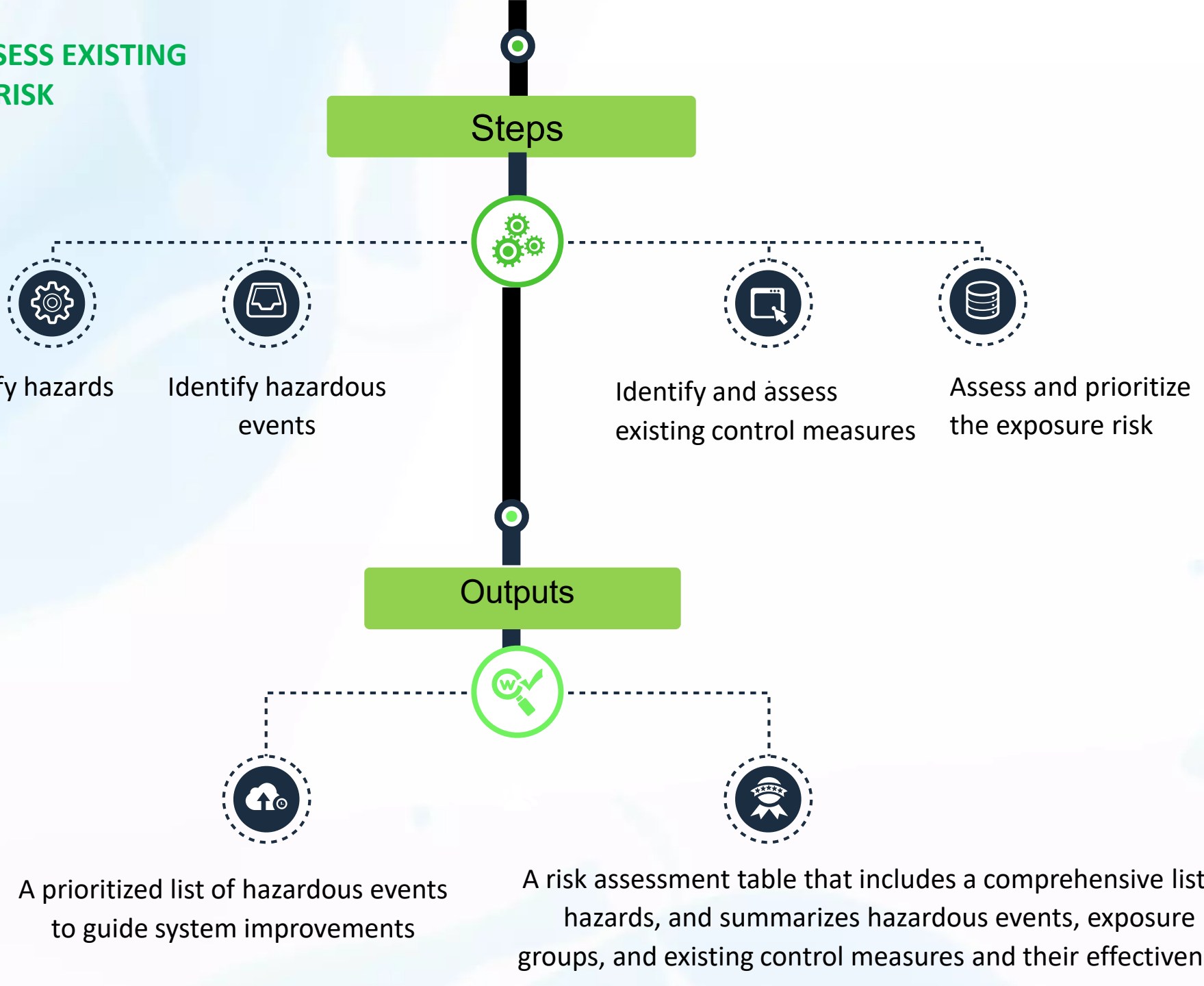
05

A compilation of relevant technical, legal and regulatory information

MODULE 3

IDENTIFY HAZARDOUS EVENTS, AND ASSESS EXISTING CONTROL MEASURES AND EXPOSURE RISKS

IDENTIFY HAZARDS AND ASSESS EXISTING CONTROLS AND EXPOSURE RISK

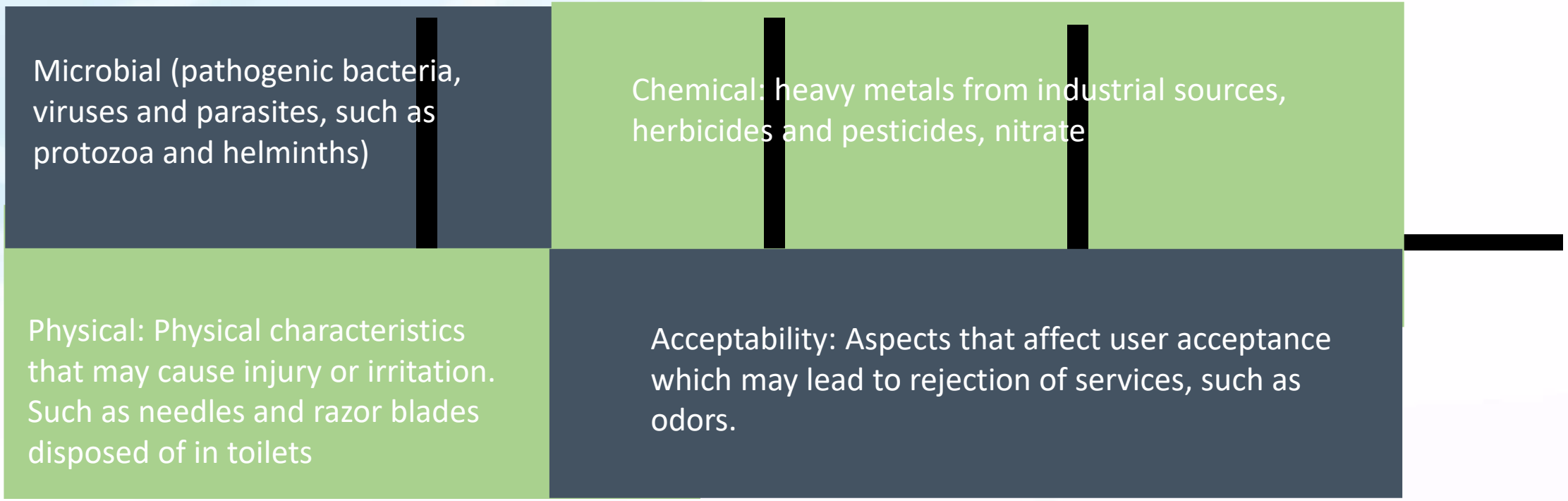


3.1 Identify hazards and hazardous events

Identifying hazards and hazardous events is crucial for risk assessment.

Hazards are biological, chemical or physical constituents that cause harm to human health.

Hazardous events introduce or release hazards to the environment, amplify their concentration, or fail to remove them. Moreover, a hazardous event can be an incident or occurrence within a sanitation system that has the potential to interrupt treatment and management along the sanitation chain.



The team should identify hazards and their associated hazardous events at each step of the sanitation chain

Ingestion after contact with wastewater or excreta

A

C

Dermal contact with wastewater

Consumption of contaminated produce (vegetables)

B

D

Inhalation of aerosols and particles

3.2 Identify and assess existing control measures

Control measures are any action or activity (or barrier) that can be used to reduce, prevent or eliminate a sanitation-related hazard or reduce it to an acceptable level.

- reduces the number of pathogens along
- contributes to a reduction in transmission of the hazard

Once existing control measures are identified, the SSP team should determine how effective they are in reducing the risk of hazardous events

Control measure validation
Establishing the theoretical and practical effectiveness of a control measure, by evidence or by judgment from experience

DEVELOP AND IMPLEMENT AN INCREMENTAL IMPROVEMENT PLAN

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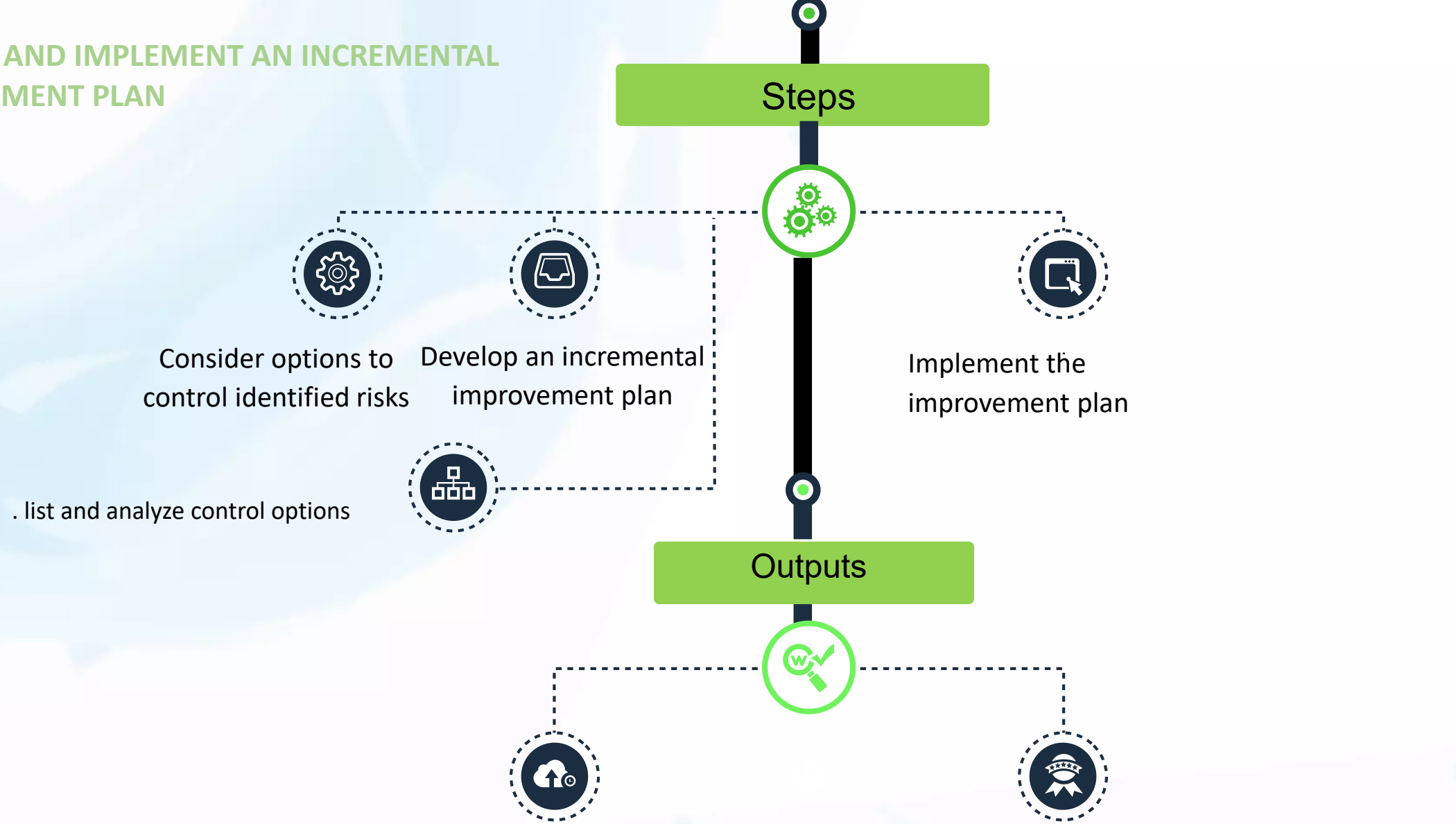
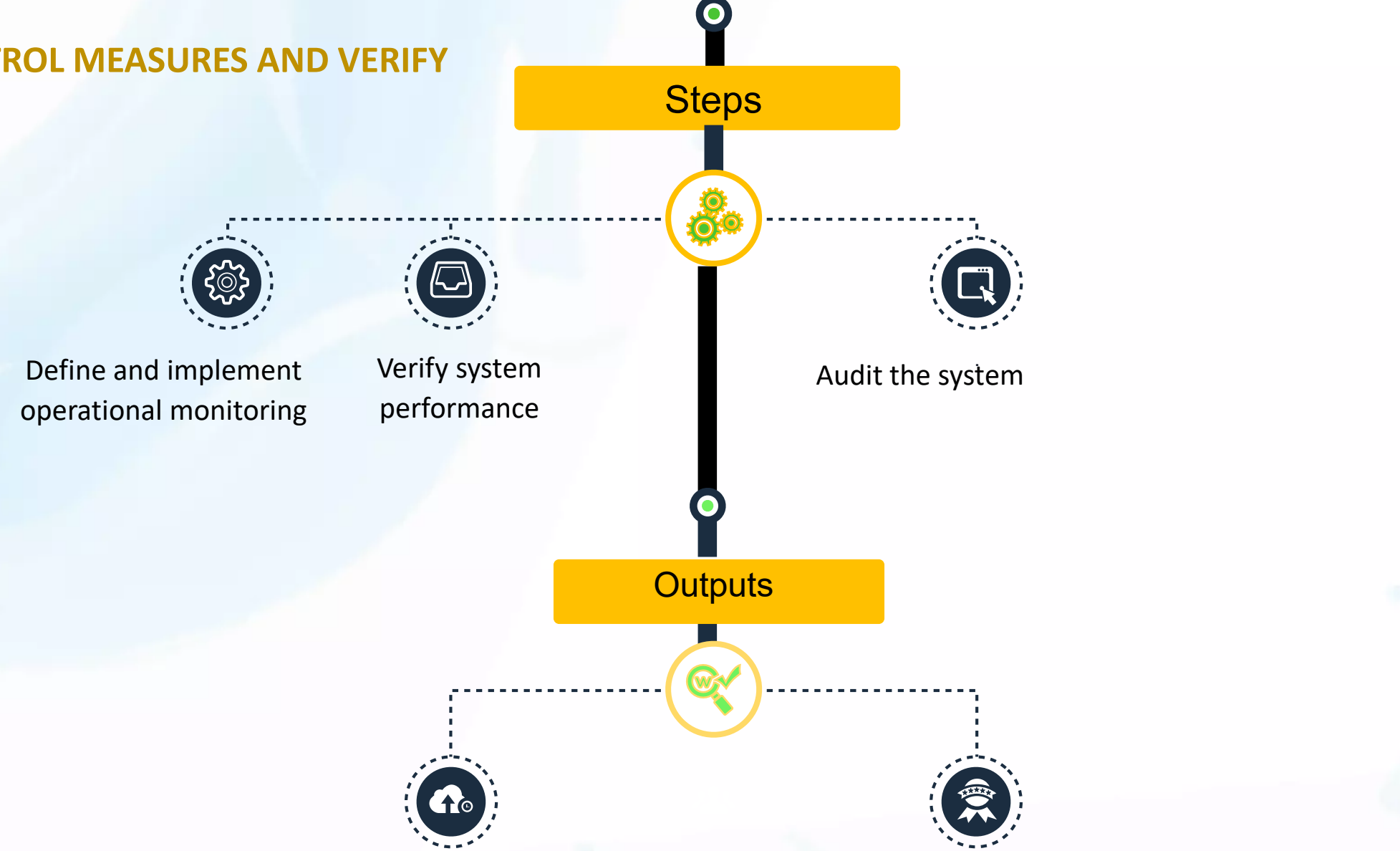


T= Treatment DO= die off
W= wash DI= drip irrigation
SSI= subsurface irrigation
H= high crop
L= low crop

MONITOR CONTROL MEASURES AND VERIFY PERFORMANCE

MONITOR CONTROL MEASURES AND VERIFY PERFORMANCE



Validation

Testing the system and its individual components to obtain evidence that it is capable of meeting the specified targets (i.e. microbial reduction targets).

Takes place when a new system is developed

Issuing licenses based on validated measures.

Responsibility

Ministry of Agriculture

Operational Monitoring

The act of conducting a planned sequence of observations or measurements of control parameters to assess whether a control system is operating within design specification..

Operational monitoring data should help managers to make corrections that can prevent hazard break through

making sure that corrective actions in response to a detected deviation are taken. (MOA).

Responsibility

Ministry of Agriculture

Verification

Responsibility

Ministry of Health

The application of methods, procedures, tests and other evaluations, to determine compliance of the system to design parameters

Asses whether the system meets specified requirements (e.g microbial or chemical specification of crops).

Compliances with standards

Validation

Studied through two field experiments

Located at the banks of Seil Al Zarqa/open field

Located at Abu-Nussier WWTP/ Green house cultivation

Seil Al-Zarqa field experiment

Irrigation water	Discharged directly from the seil
Irrigation method	Drip irrigation
Cropping pattern	Bell pepper, zucchini and cabbage

Irrigation water	**Disinfected secondary effluent** **Secondary effluent** **Fresh water**
Cropping pattern	**High growing tomato** **Lettuce**
Irrigation method	**Drip irrigation/tomato** **Sub-surface drip irrigation/lettuce**

Parameter	unit		JS (893/2006)*
pH		8.2 (6)**	6-9
Total suspended solids (TSS)	mg/l	20.2 (6)	50
Total Dissolved solids (TDS)	mg/l	1157.0 (6)	1500
COD	mg/l	57.3 (6)	100
BOD	mg/l	6.8 (6)	30
sodium	mg/l	208.3 (6)	230***
Calcium	mg/l	53.5 (6)	230***
Magnesium	mg/l	25.8 (6)	100***
Potassium	mg/l	34.5 (6)	
Total N	mg/l	15.9 (6)	45
Ammonium as NH_4	mg/l	0.3 (6)	-
Nitrate as NO_3	mg/l	47.6 (6)	30
Carbonate	mg/l	3.2 (6)	
total alkalinity	mg/l	204.0 (6)	
Boron	mg/l	8.2 (6)	1.0***
e-coli	MPN/100 ml	2353 (4) >160,000(1) >1600(1)	100
total coliform	MPN/100 ml	1.4E+04 (4) >160,000(1) >1600(1)	

Seil Al Zarqa Irrigation water

Parameter	Unit	Fresh water	Secondary effluent	Disinfected effluent	JS (893/2006)*
pH	unit	7.806 (6)	7.6 (6)	6.6(6)	6-9
Total suspended solids (TSS)	mg/l	<5(6)	10.2(6)	7.5(6)	50
Total Dissolved solids (TDS)	mg/l	374(6)	727.2(6)	821.6(6)	1500
COD	mg/l	14(6)	55.8(6)	38.4(6)	100
BOD	mg/l	<3(6)	17.4(6)	17.3(6)	30
sodium	mg/l	55.0(6)	136.5(6)	148.1(6)	230***
Calcium	mg/l	29.2(6)	38.1(6)	45.7(6)	230***
Magnesium	mg/l	13.7(6)	17.594(6)	18.0(6)	100***
Potassium	mg/l	16.4(6)	26.5(6)	28.4(6)	
Total N	mg/l	2.52(6)	13.9(6)	10.2(6)	45
Ammonium as NH4	mg/l	0.3(6)	3.6(6)	7.7(6)	-
Nitrate as NO3	mg/l	6.9(6)	5.7(6)	1.6(6)	30
Carbonate	mg/l	<2.5(6)	<2.5(6)	<2.5(6)	
total alkalinity	mg/l	100.2(6)	207.8(6)	99.5(6)	
e-coli	MPN/100 ml		600 (2) >1600 (1) >16000 (1)		100
total coliform	MPN/100 ml	<1.8	920 (1) >1600 (2) >16000 (1) >	<1.8	-

Abu Nussier WWTP effluent

Crop quality and microbial contamination

Microbiological quality of zucchini produce/Zarqa River pilot farm

Parameter	After 2 days of last irrigation		After 3 days of last irrigation		After 4 days of last irrigation	
	At harvesting	After packaging	At harvesting	After packaging	At harvesting	after packaging
Total coliform (CFU/g)	0/2	0/2	1/2 2×10^3	1/2 6×10^2	0/2	0/2
***e-coli* (CFU/g)**	0/2	0/2	1/2* 5×10^2	1/2 2×10^2	0/2	0/2
Salmonella (pre/abs in 25g)	Abs/2	Abs/2	Abs/2	Abs/2	Abs/2	Abs/2

Microbiological quality of cabbage/Zarqa River pilot farm

Parameter	After 2 days of last irrigation	After 3 days of last irrigation
	At harvesting	At harvesting
Total coliform (CFU/g)	1/4	0/4
e-coli (CFU/g)	1/4	0/4
Salmonella (pre/abs in 25g)	-	-

Crop quality and microbial contamination

Microbiological quality of cabbage/Zarqa River pilot farm

Parameter	After 2 days of last irrigation		After 3 days of last irrigation		After 4 days of last irrigation	
	At harvesting	After packaging	At harvesting	After packaging	At harvesting	After packaging
Total coliform (CFU/g)	0/4	0/4	0/4	0/4	0/4	3/4
***e-coli* (CFU/g)**	0/4	0/4	0/4	0/4	0/4	3/4
Salmonella (pre/abs in 25g)	Abs /4	Abs/4	Abs /4	Abs /4	Abs /4	Abs /4

Crop quality and microbial contamination /Abu-Nussier

Microbiological quality of tomato fruits sampled after one day of last irrigation event

	Fresh water	Secondary effluent	Disinfected effluent
Total coliform (CFU/g)	0/3	0/7	0/7*
***e-coli* (CFU/g)**	0/3	0/7	0/7
Salmonella (pre/abs in 25g)	Abs/3	Abs/7	Abs/7

Microbiological quality of tomato fruits sampled after two days of last irrigation event

	Fresh water	Secondary effluent	Disinfected effluent
Total coliform (CFU/g)	0/5	0/6	0/6
***e-coli* (CFU/g)**	0/5	0/6	0/6
Salmonella (pre/abs in 25g)	Abs/5	Abs/6	Abs/6

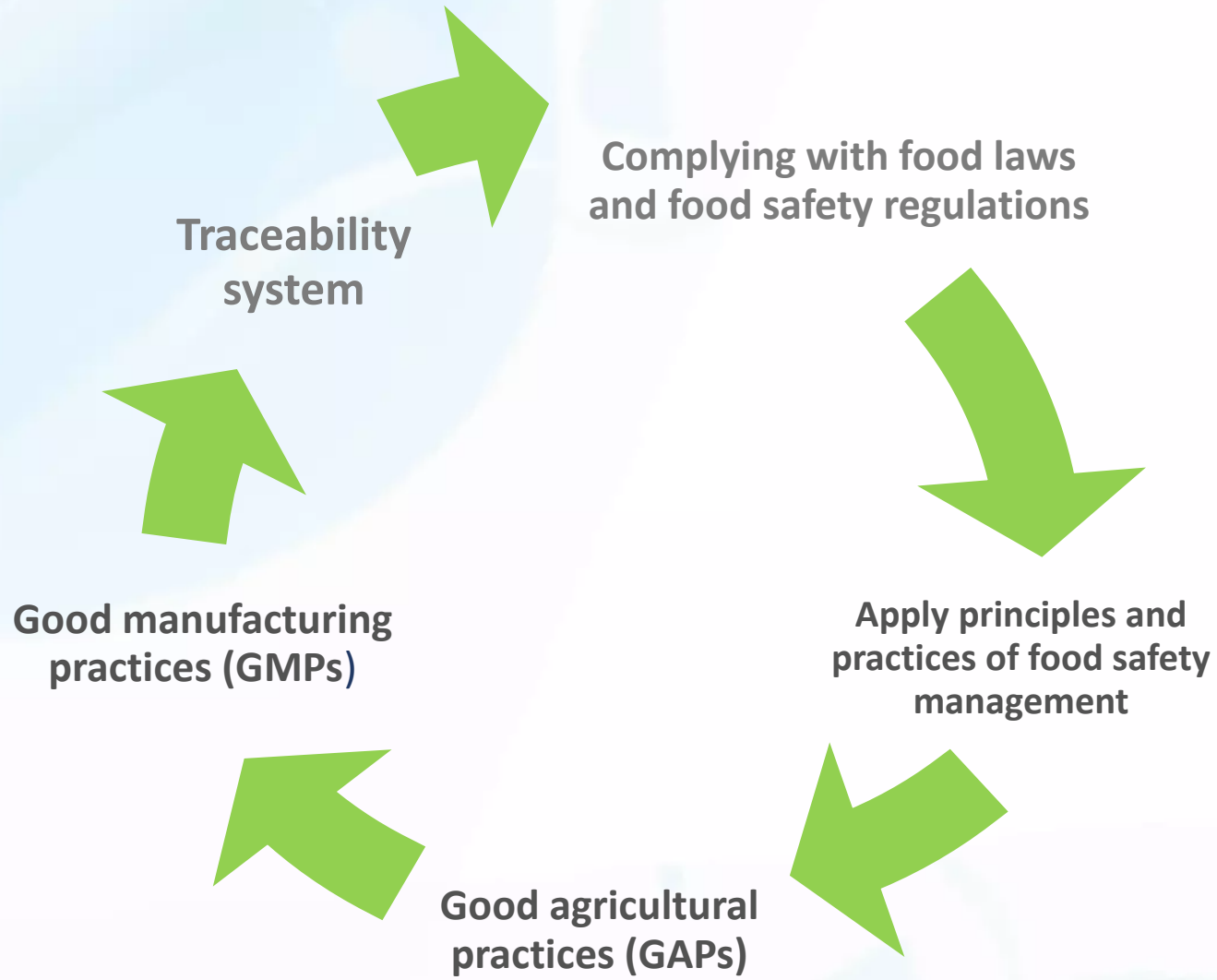
Microbiological quality of lettuce samples after two days of last irrigation event

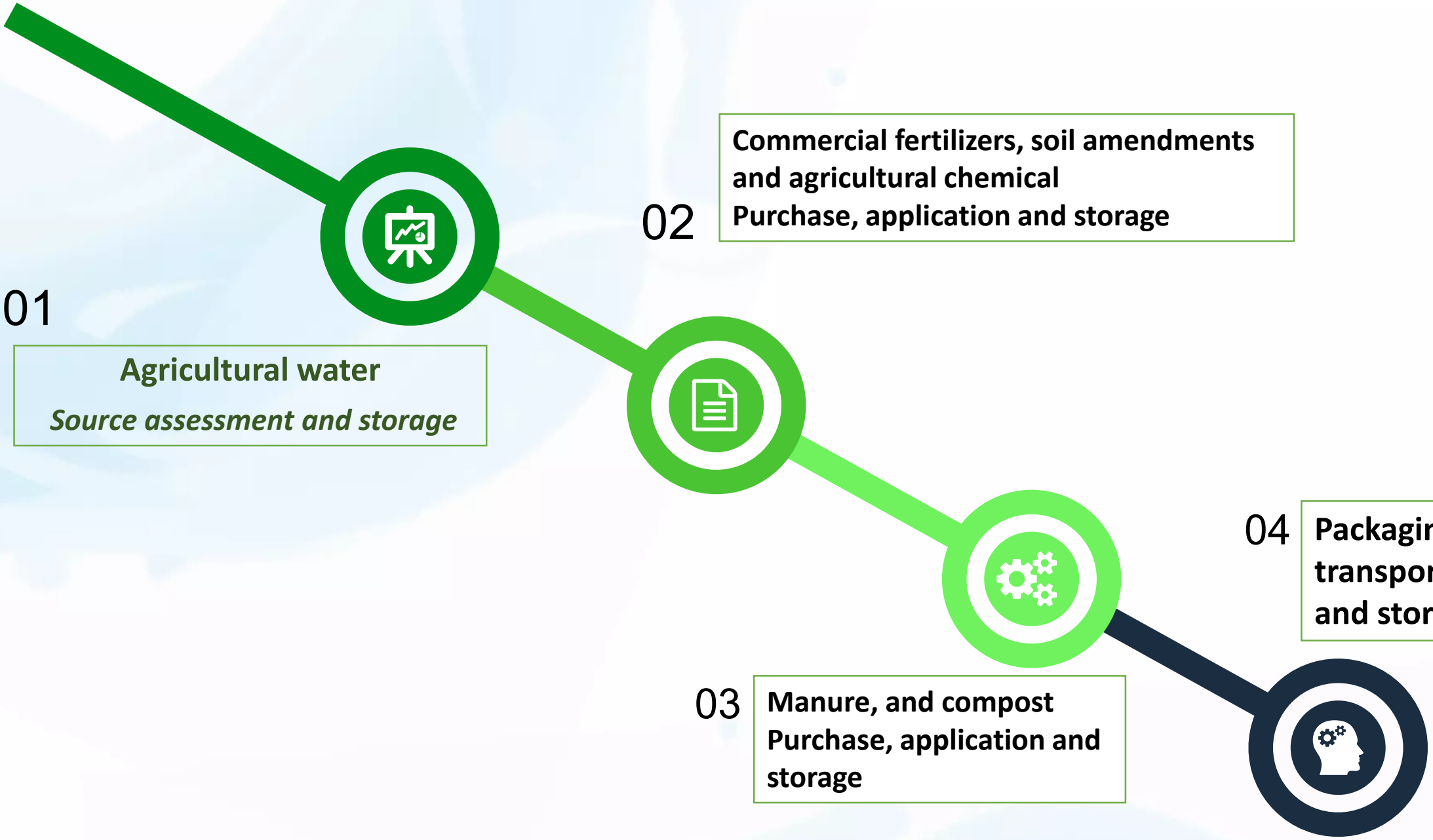
	Fresh water	Secondary effluent	Disinfected effluent
Total coliform (CFU/g)	0/3*	0/3*	0/3*
***e-coli* (CFU/g)**	0/3	0/3	0/3
Salmonella (pre/abs in 25g)	Abs/3	Abs/3	Abs/3

Results have shown **that high growing cultivation**, **use of drip irrigation, use of mulch and allowing a pathogen die off period of at least one day** results in microbiologically safe crop, even for the fruits touching the ground.

Results that use of **sub-surface drip irrigation** and **allowing a pathogen die off period of two days** results in microbiologically safe crop.

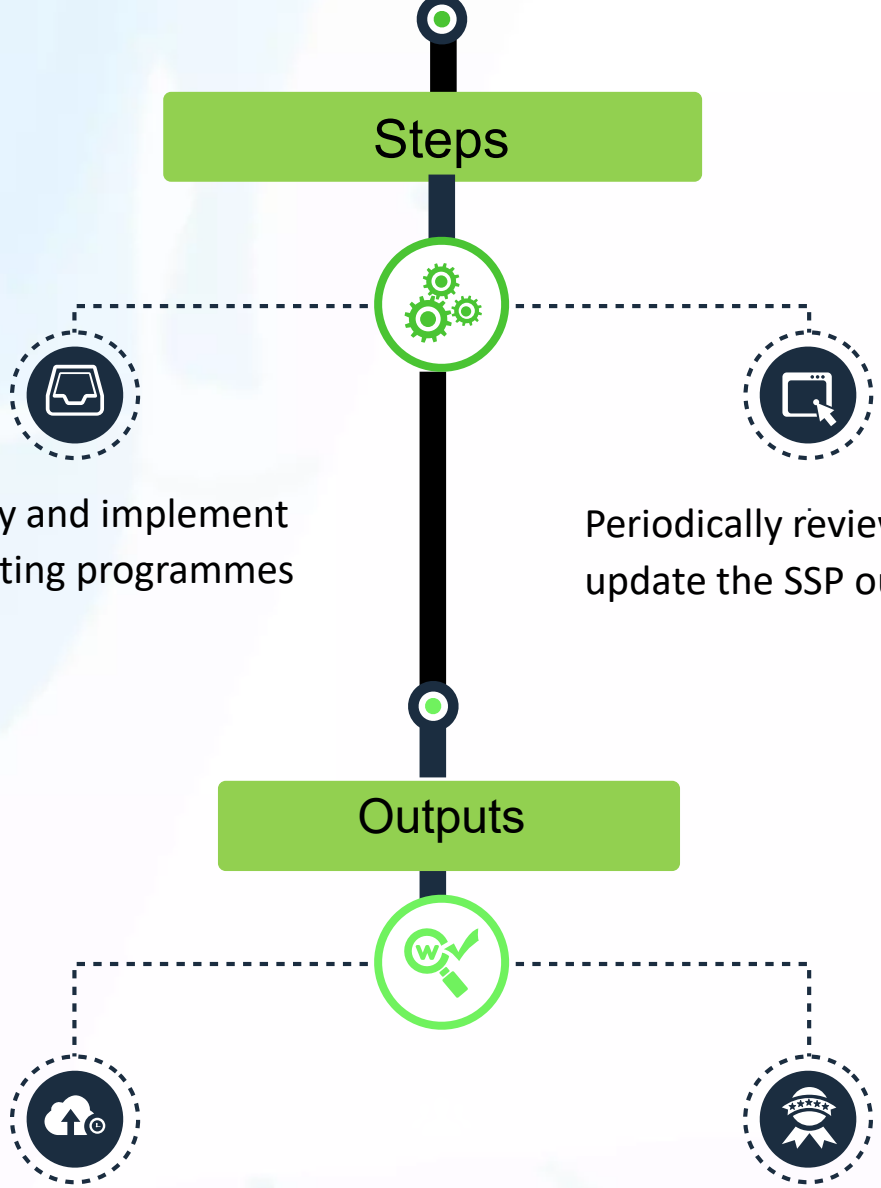
These results demonstrate clearly that irrigation water is not the lone source of contamination.




01
Agricultural water
Source assessment and storage
02
Commercial fertilizers, soil amendments and agricultural chemical Purchase, application and storage
03
Manure, and compost Purchase, application and storage
04
Packaging, transportation and storage

DEVELOP SUPPORTING PROGRAMMES AND REVIEW PLANS

DEVELOP AND IMPLEMENT AN INCREMENTAL IMPROVEMENT PLAN



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