Title

OPTIMIZATION OF INTEGRATED WATER QUALITY MANAGEMENT FOR AGRICULTURAL EFFICIENCY AND ENVIRONMENTAL CONSERVATION IN THE NILE DELTA

By

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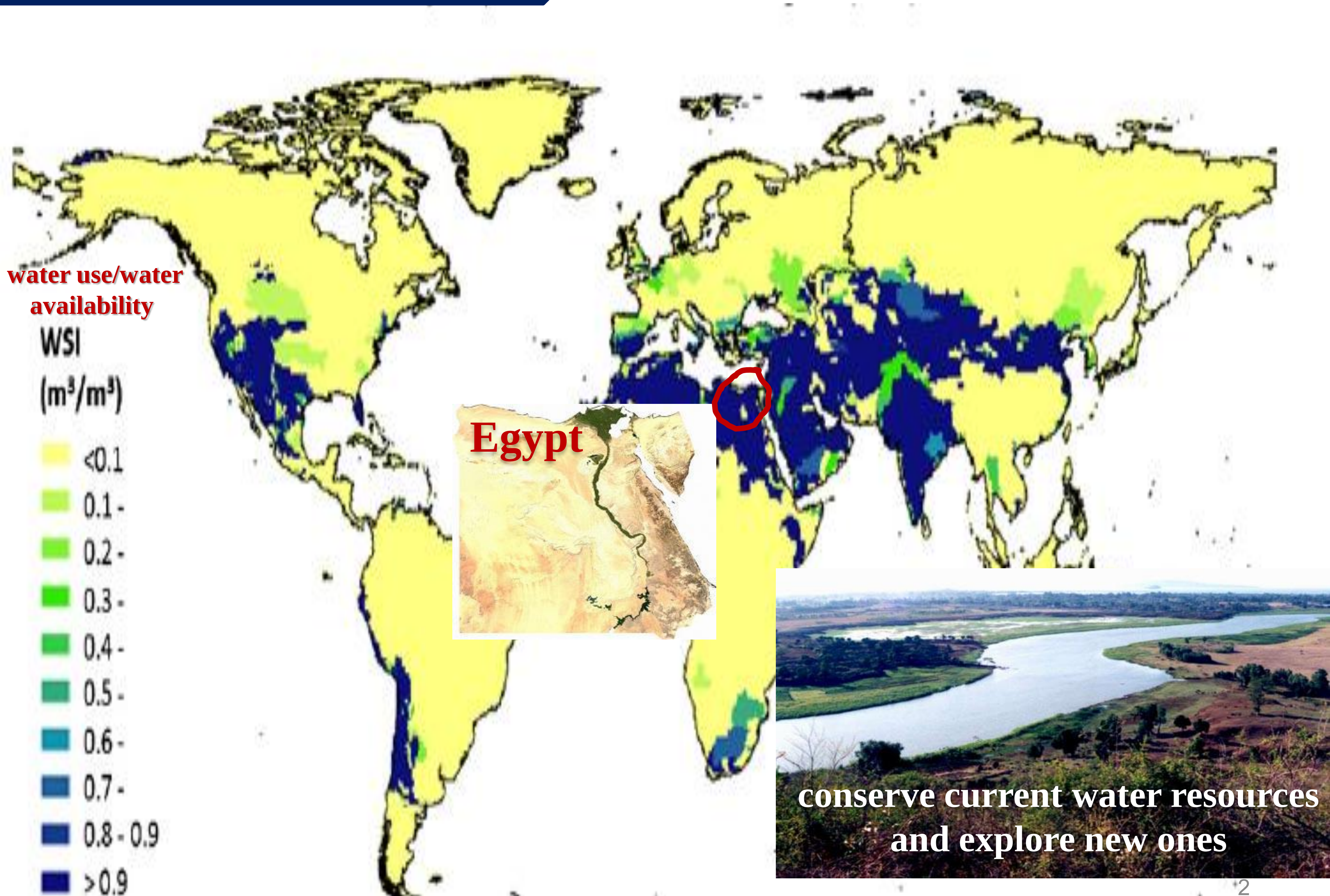
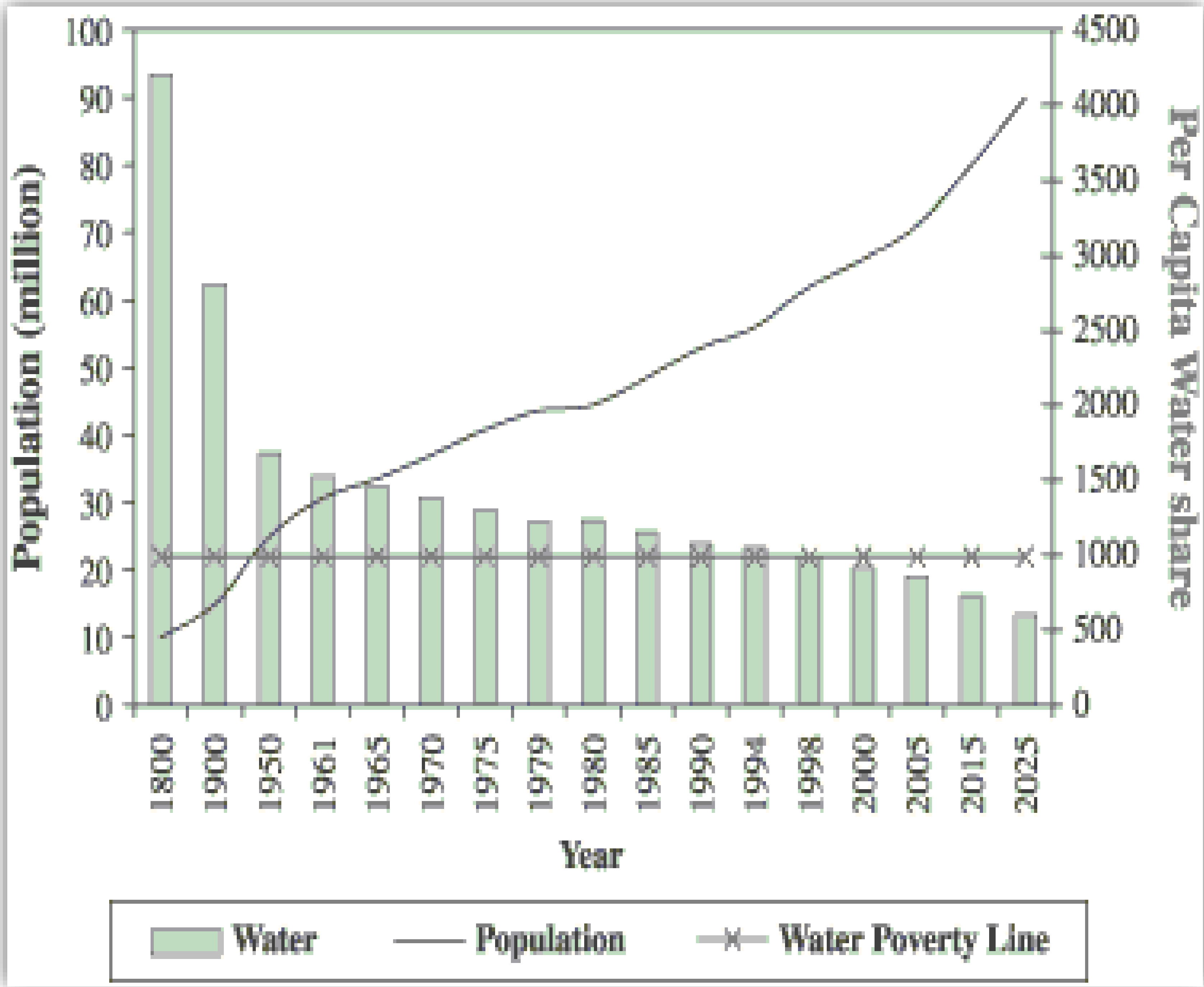
1. Introduction



.source: Global representation of the water stress index (Pfister et al., 2009)



Population (million)
Per Capita Water share
Year
0
10
20
30
40
50
60
70
80
90
100
0
500
1000
1500
2000
2500
3000
3500
4000
4500
1800
1900
1950
1961
1965
1970
1975
1979
1980
1985
1990
1994
1998
2000
2005
2015
2025
Water
Population
Water Poverty Line

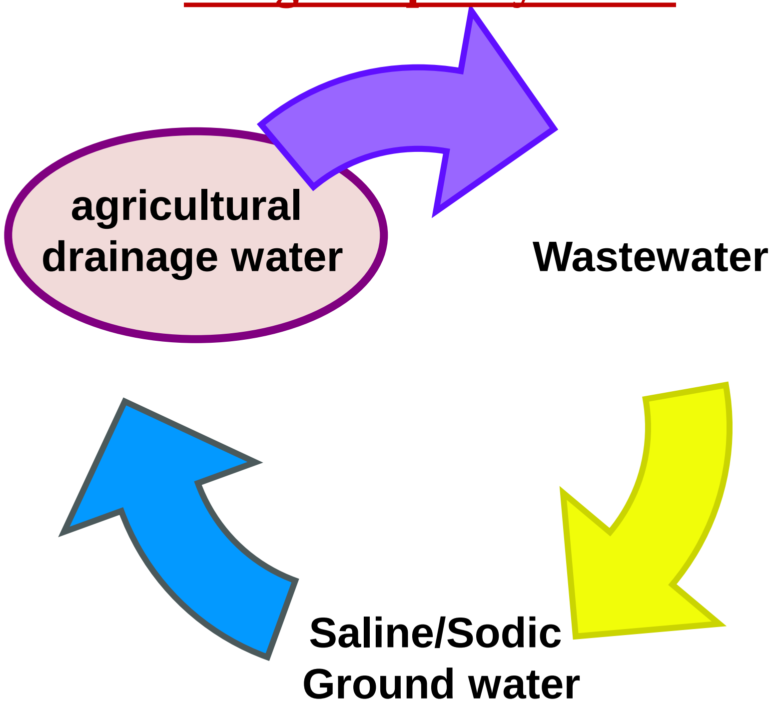
Water Resources

Non-conventional water resources

Desalinated seawater

Water harvesting

Marginal-quality water



- Nile River (55.5 BCM/y)
- Shallow G W. (6.2 BCM/y)
- Deep G W. (1.3 BCM/y)
- Rains (1.3 BCM/y)

Water Uses

Demand: Agriculture (84.5%) Domestic (6%) Industry (9.5%)

<u>**WQ standard for irrigation (Law 48/1982)**</u>

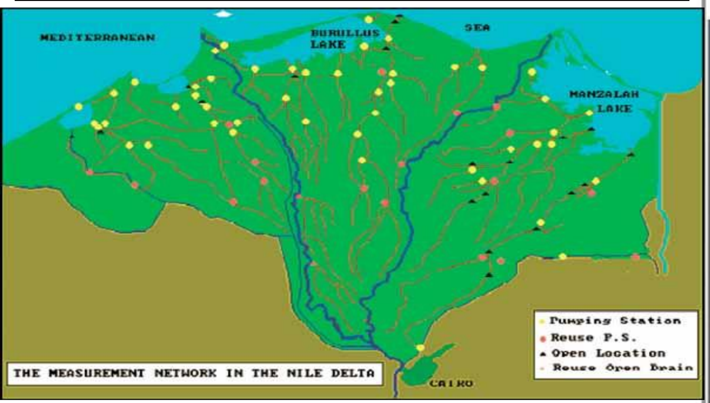
COD total	80 mg/l
BOD_5 total	40 mg/l
DO	4 mg/l
TSS	50 mg/l
NO_3-N	50 mg/l
F-coli	5×10^3 MPN/100ml

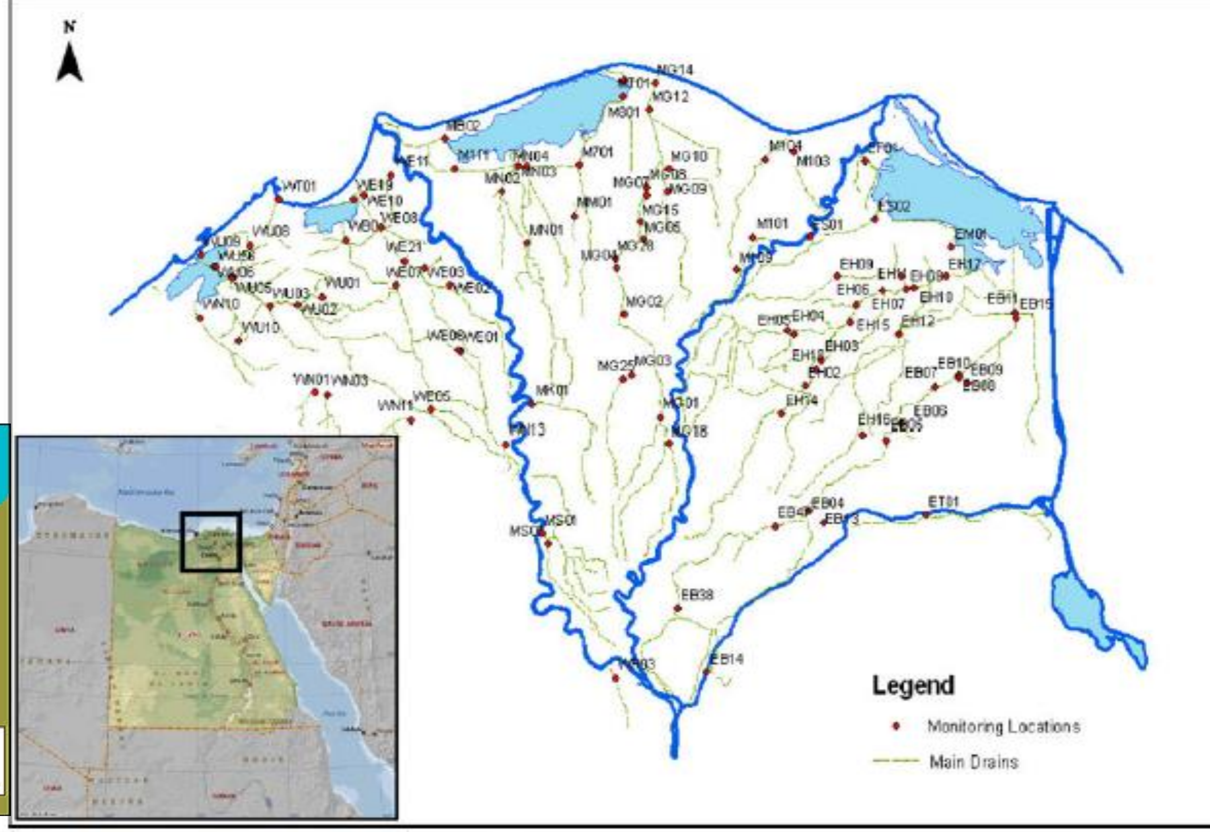
1- Official reuse

2- Unofficial reuse

3- Emergency reuse

The monitoring of the quality and quantity of ADW in the Nile Delta has shown the possibility to reuse a part of this water in irrigation





17-19 BCM/year Available → **6.5** BCM/year Reused → **8** BCM/year Target by 2017

However, increasingly widespread pollution in the drainage system threatens the current and suggested reuse projects.

→ **mixing is feasible if drain water is not too polluted**

source: DRI,2007 and NWRC

Sources of Pollution in Drains

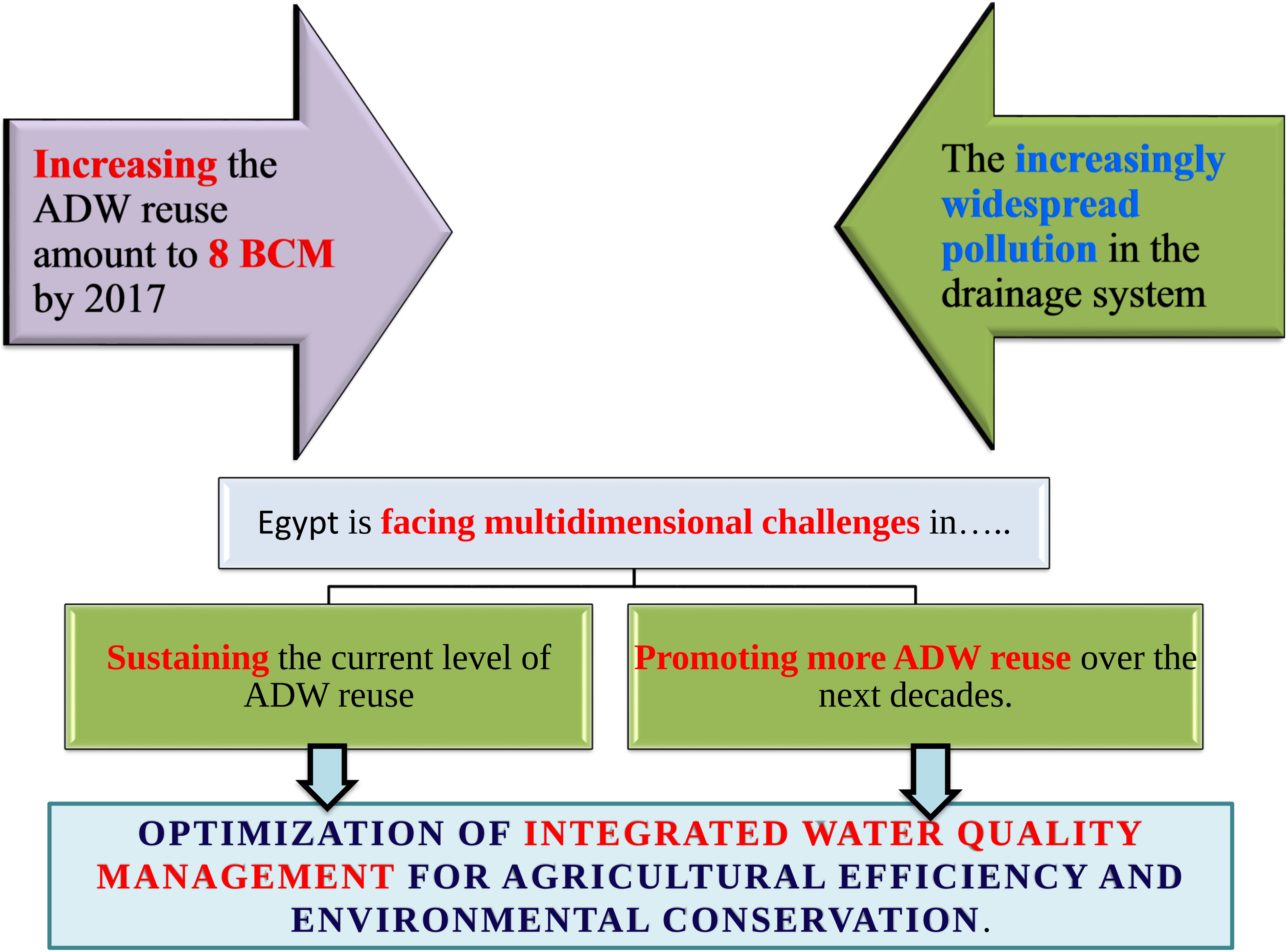
1 Domestic Point sources → Wastewater Treatment Plant → DRAINS

2 Domestic Non-Point sources
- Direct Discharge → DRAINS
- From Septic Tank to Underground Flow → DRAINS

3 Industrial Point Source → Wastewater Treatment Plant → DRAINS

4 Agricultural Non-Point sources
- Direct Discharge → DRAINS
- From Underground Flow → DRAINS

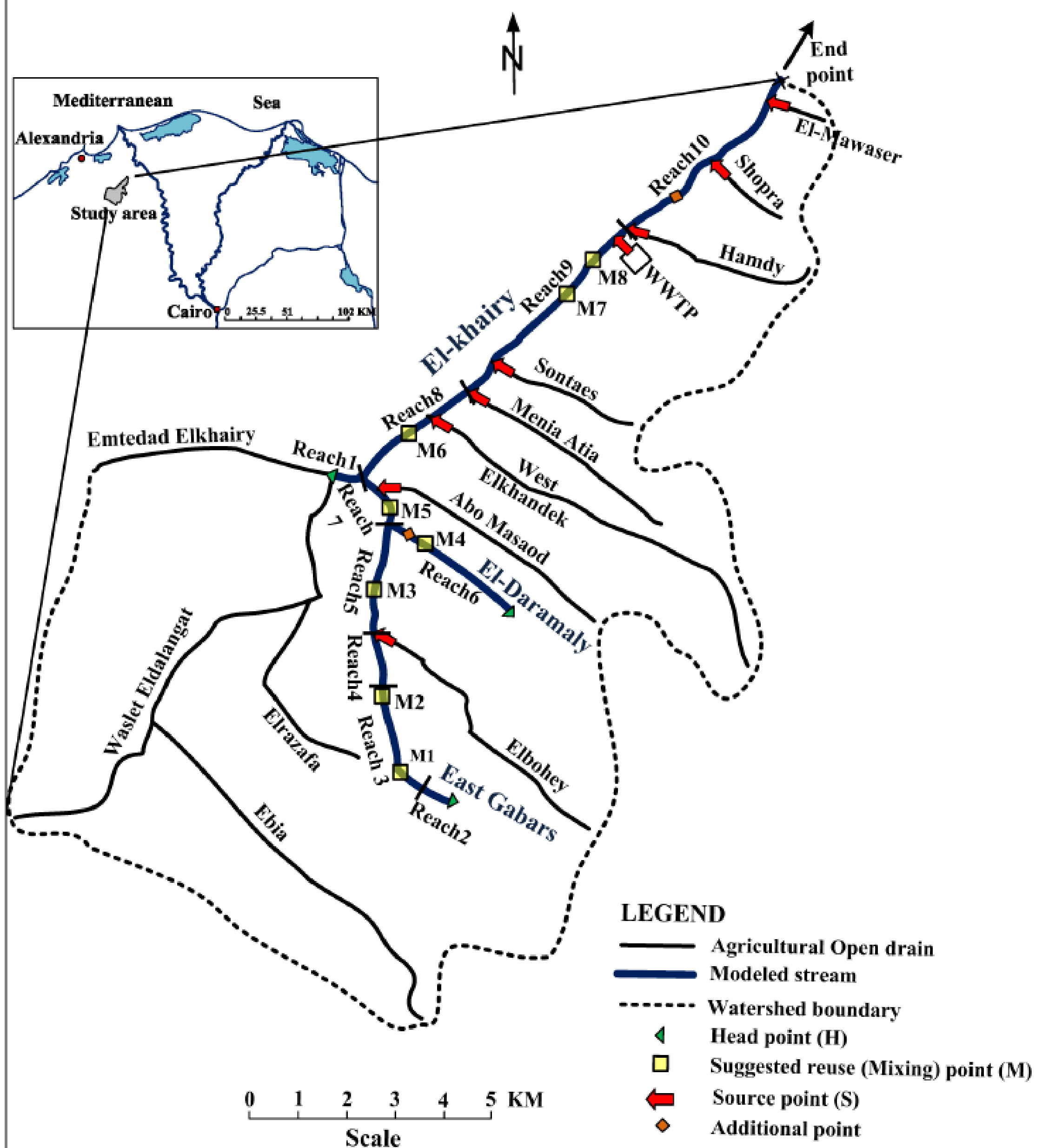
D R A I N S

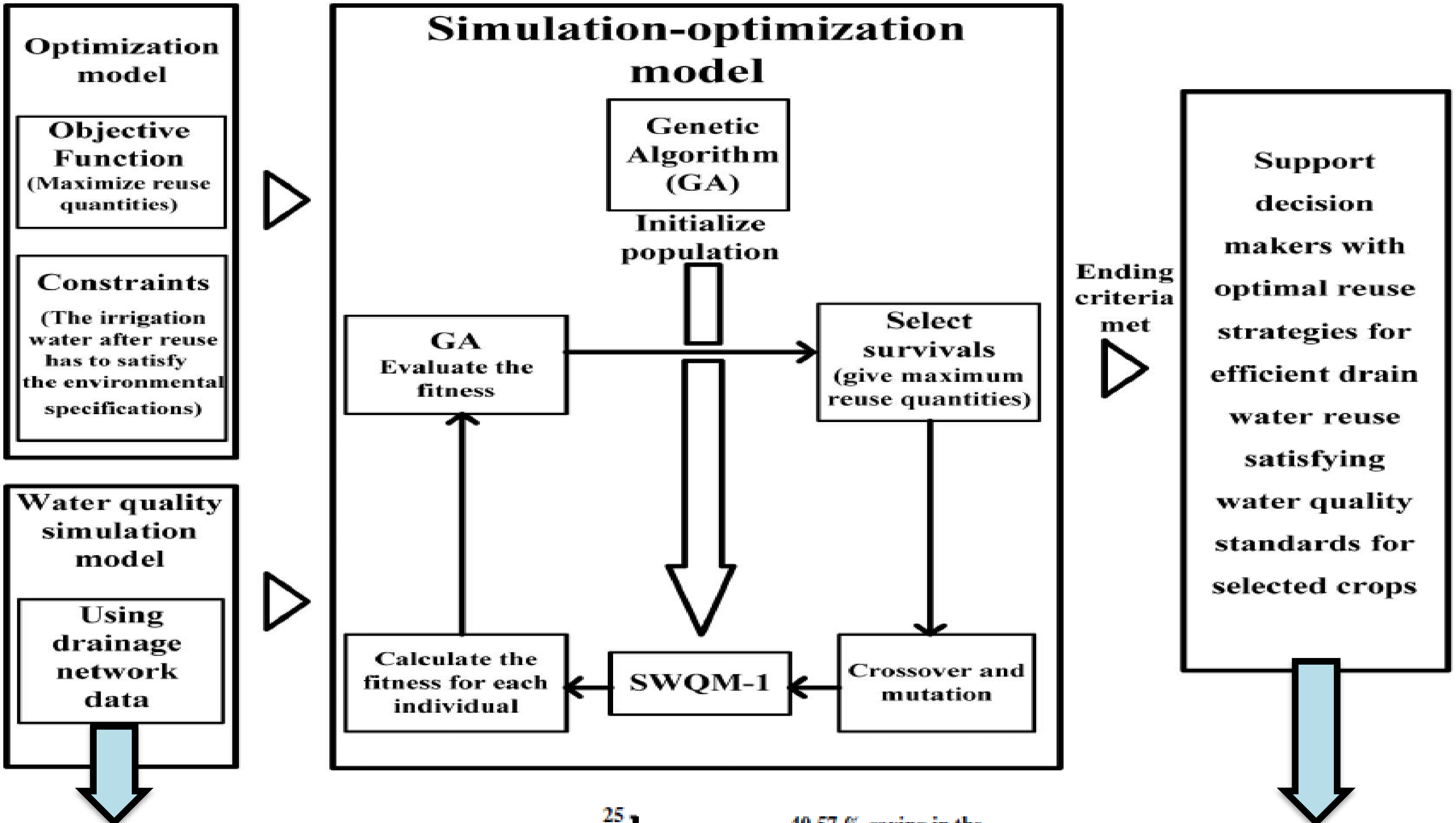

Increasing the ADW reuse amount to 8 BCM by 2017
The increasingly widespread pollution in the drainage system
Egypt is facing multidimensional challenges in…..
Sustaining the current level of ADW reuse
Promoting more ADW reuse over the next decades.
OPTIMIZATION OF INTEGRATED WATER QUALITY MANAGEMENT FOR AGRICULTURAL EFFICIENCY AND ENVIRONMENTAL CONSERVATION.

2. Simulation-Optimization Model for Intermediate Reuse of Agriculture Drainage Water in Egypt

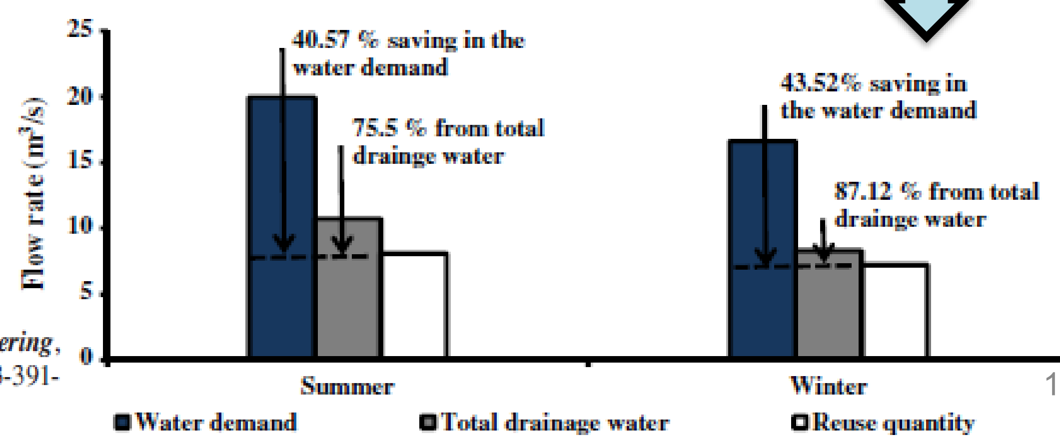
The criteria for selection Reuse locations

- The distance between the drain and canal where mixing occurs should not exceed 1 km;
- Mixing locations should be downstream from the current and future drinking water intakes;
- The mixing location should also be upstream from outflows of point source pollution, such as the wastewater treatment plants of factory outlets; and
- The quantity and quality of the drainage water should satisfy canal water quality criteria after mixing.



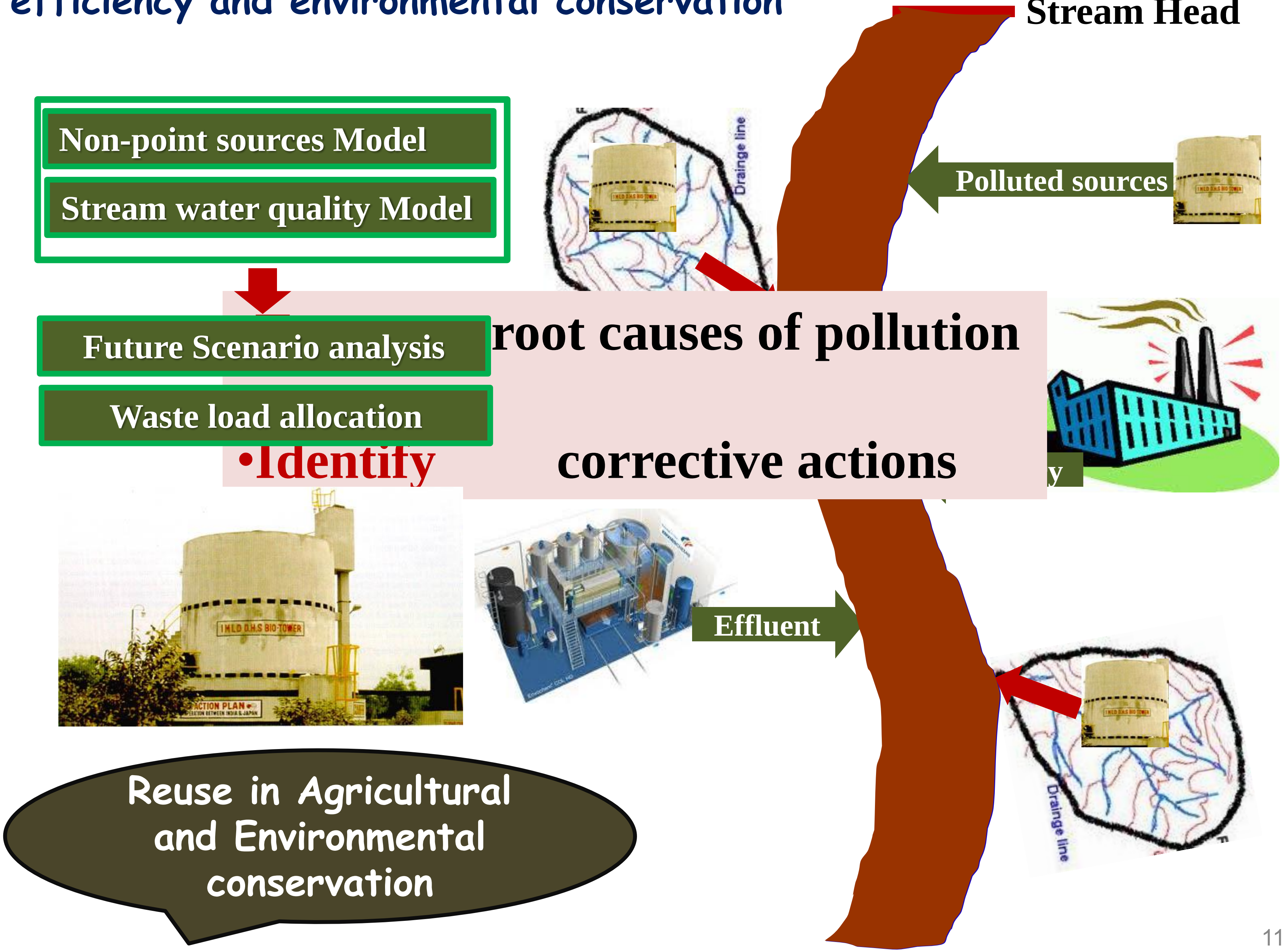


TDS, BOD, DO



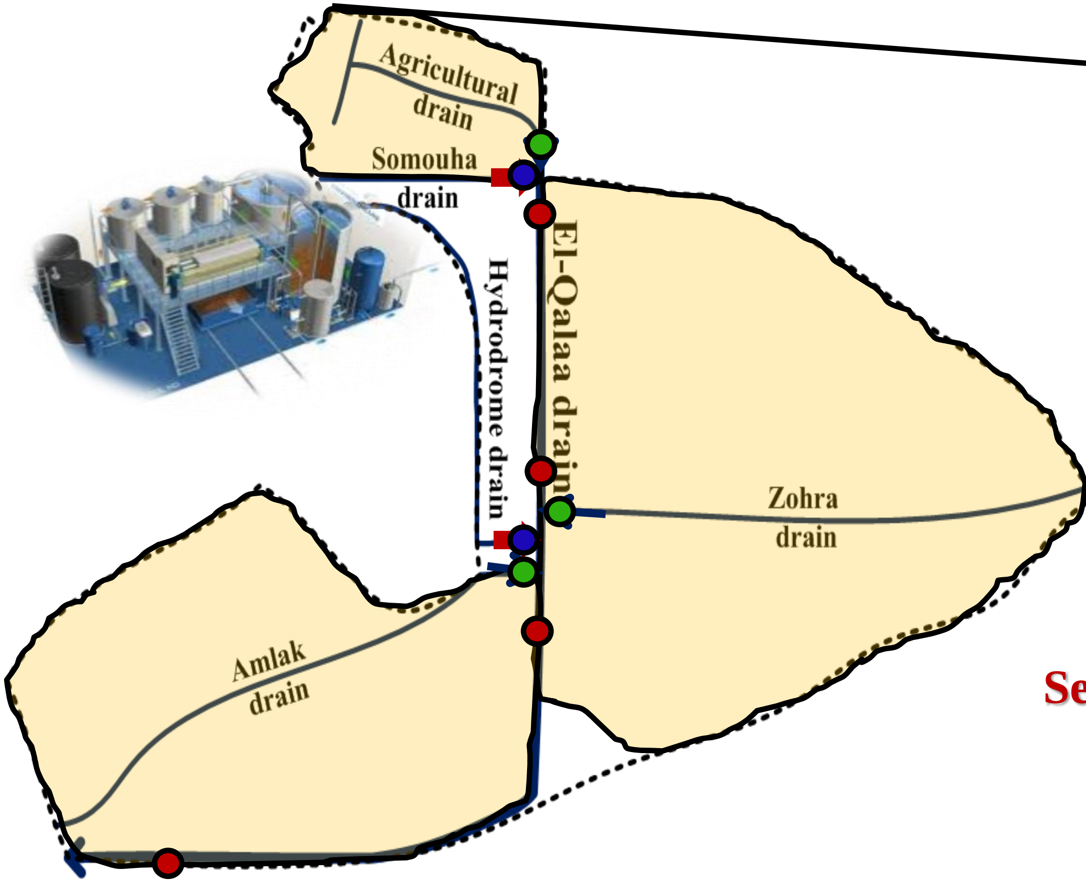
papers. This paper is part of the *Journal of Environmental Engineering*, Vol. 139, No. 3, March 1, 2013. © ASCE, ISSN 0733-9372/2013/3-391-401/$25.00.

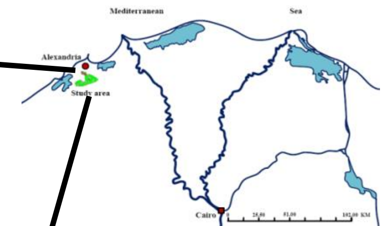
3. Optimization of integrated water quality management for agricultural efficiency and environmental conservation



Study area

El-Qalaa basin

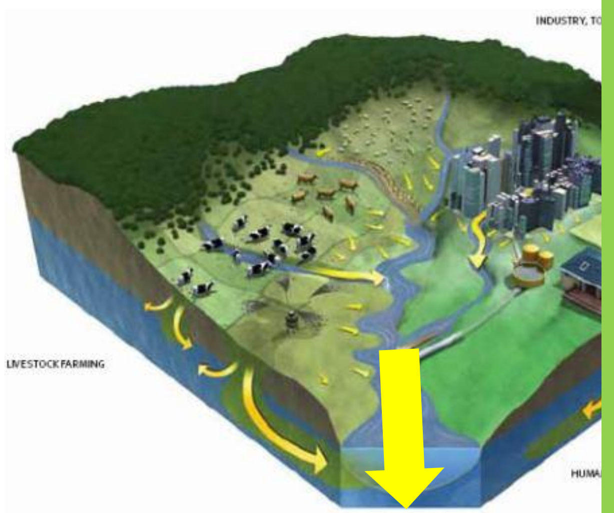




Served area 33500 fed

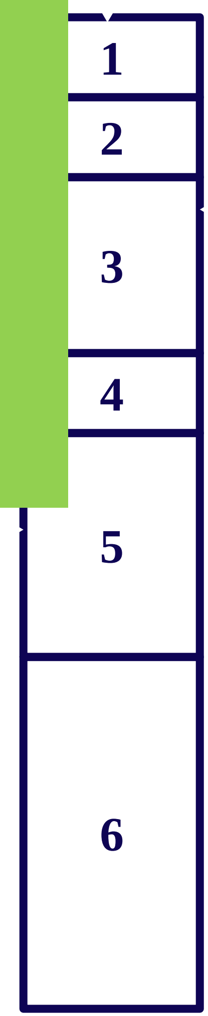
1. Water quality simulation

Export coefficient model ⟷ QUAL2kw



Simulated parameters

- Dissolved Oxygen DO
- pH
- COD
- BOD_5
- TSS
- TDS
- NH_4-N
- NO_3-N
- PO_4



Supervised classification

(ETM+) image acquire on 17 July 2007 (Under clear atmospheric conditions) Spatial resolution 30m

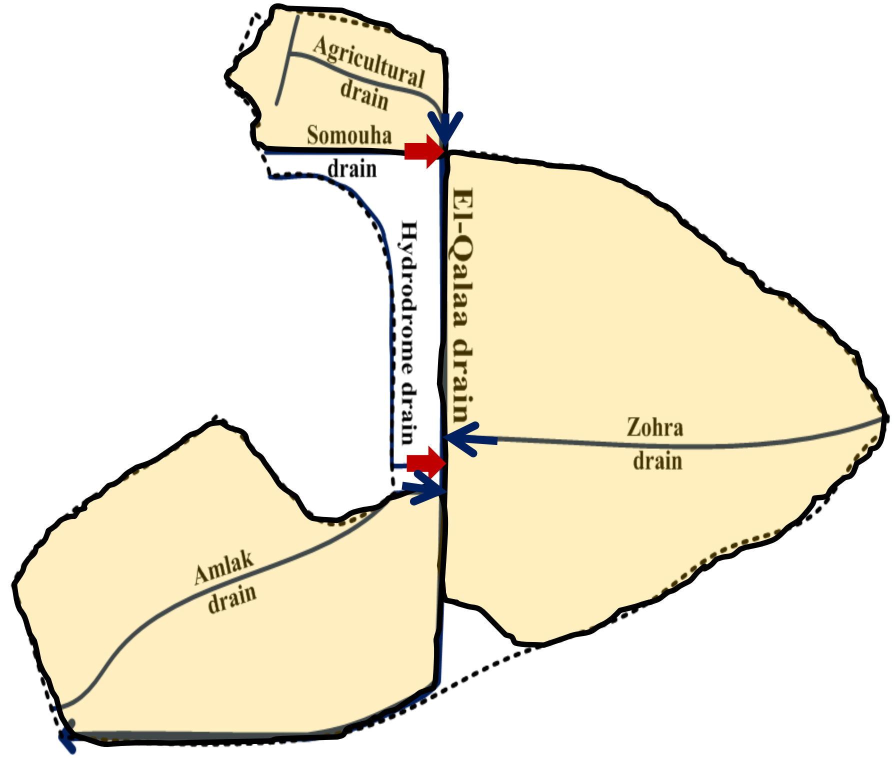
EC for each Land use

Monthly monitoring for one year

2. Optimization for waste load allocation

Decision variables

1. Treated quantities from non-point sources (Urban & Rural)



2. Treated quantities from point sources

3. Removal fractions for point and non-point sources

Objective functions

Objective 1 (min. treatment cost)

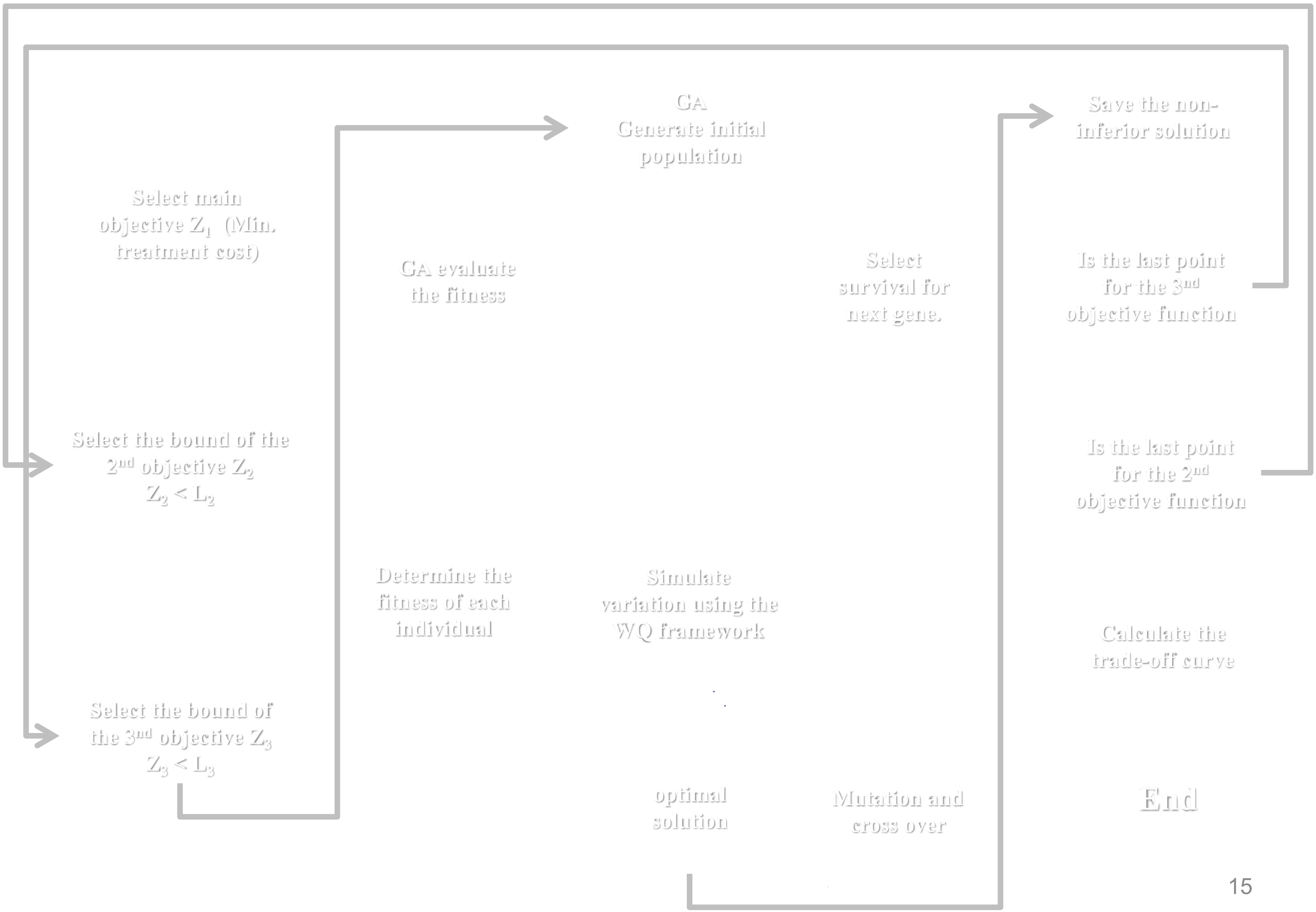
Objective 2

Min. the difference of COD and TSS with the std

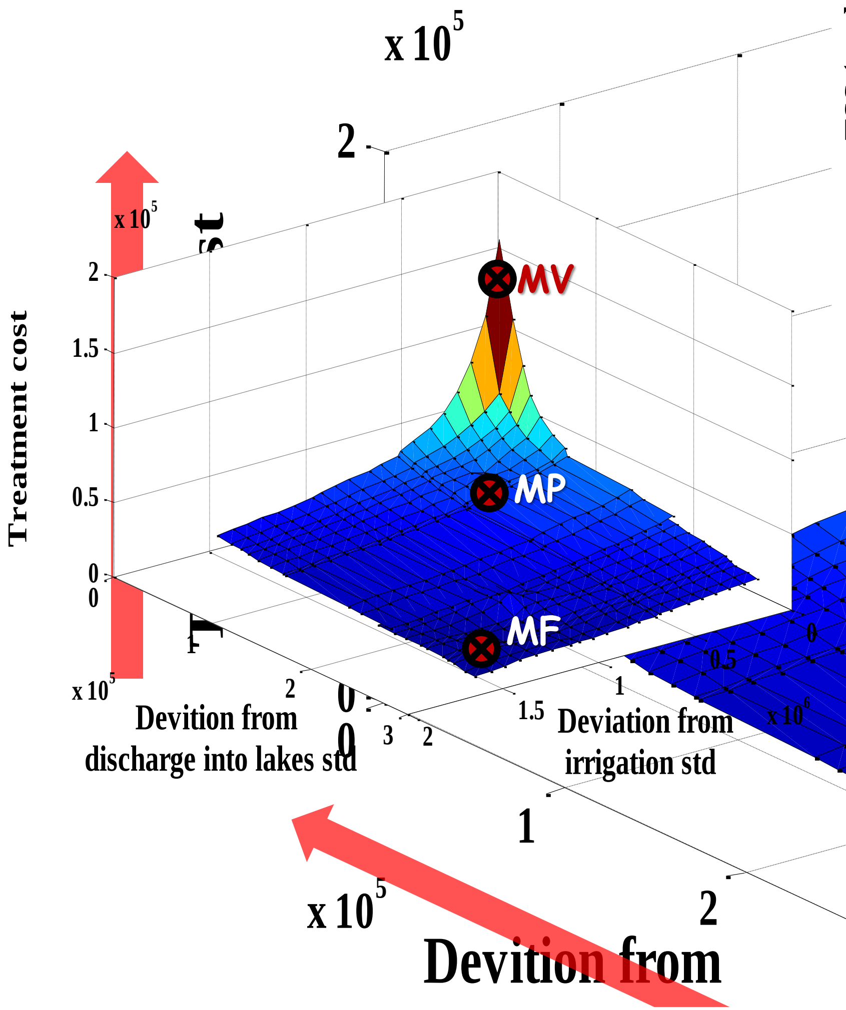
Objective 3

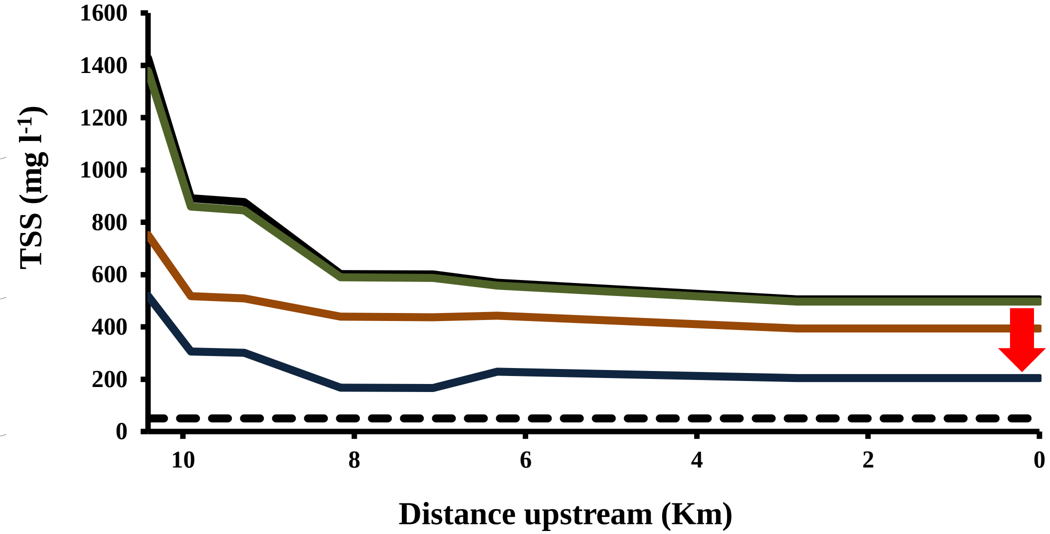
Min. the difference of COD and TSS at the end with the std

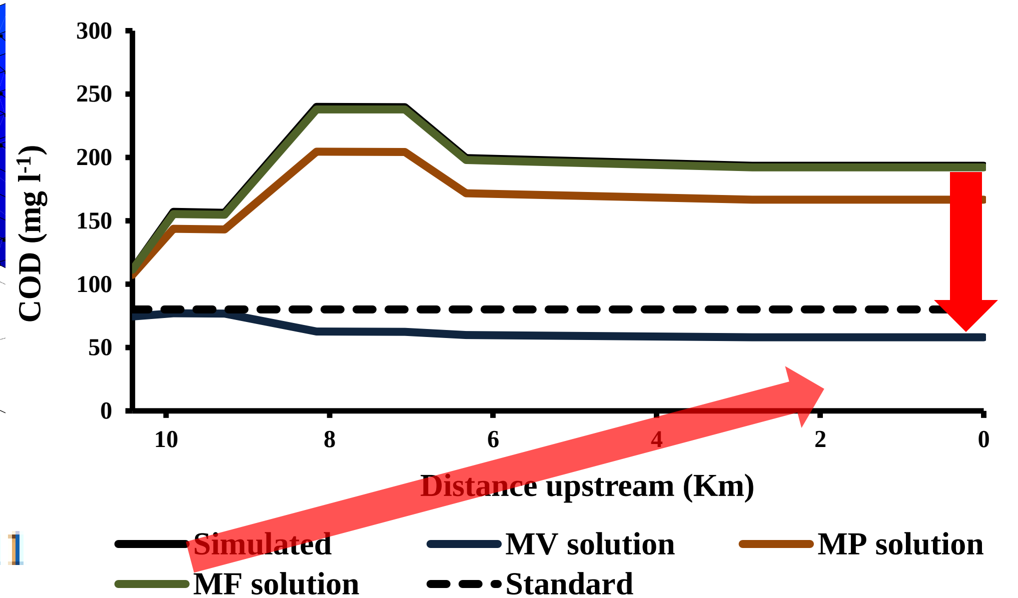
ε-constraint method and GA Model



WLA results



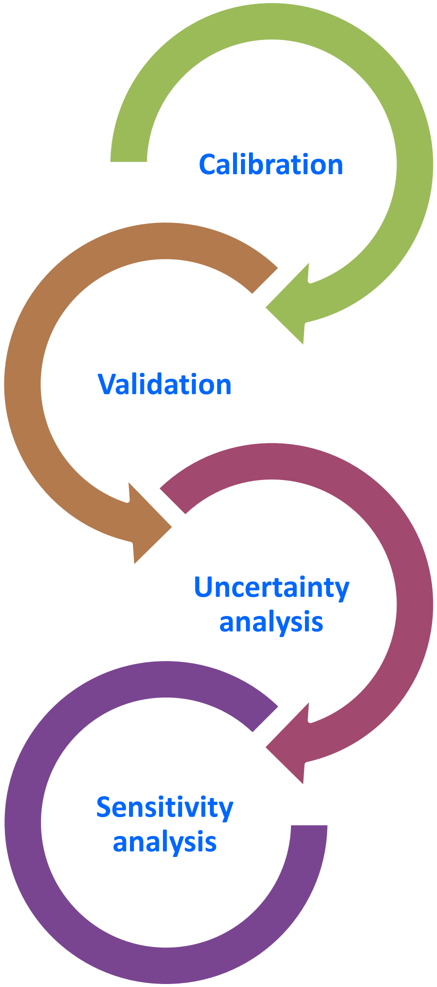




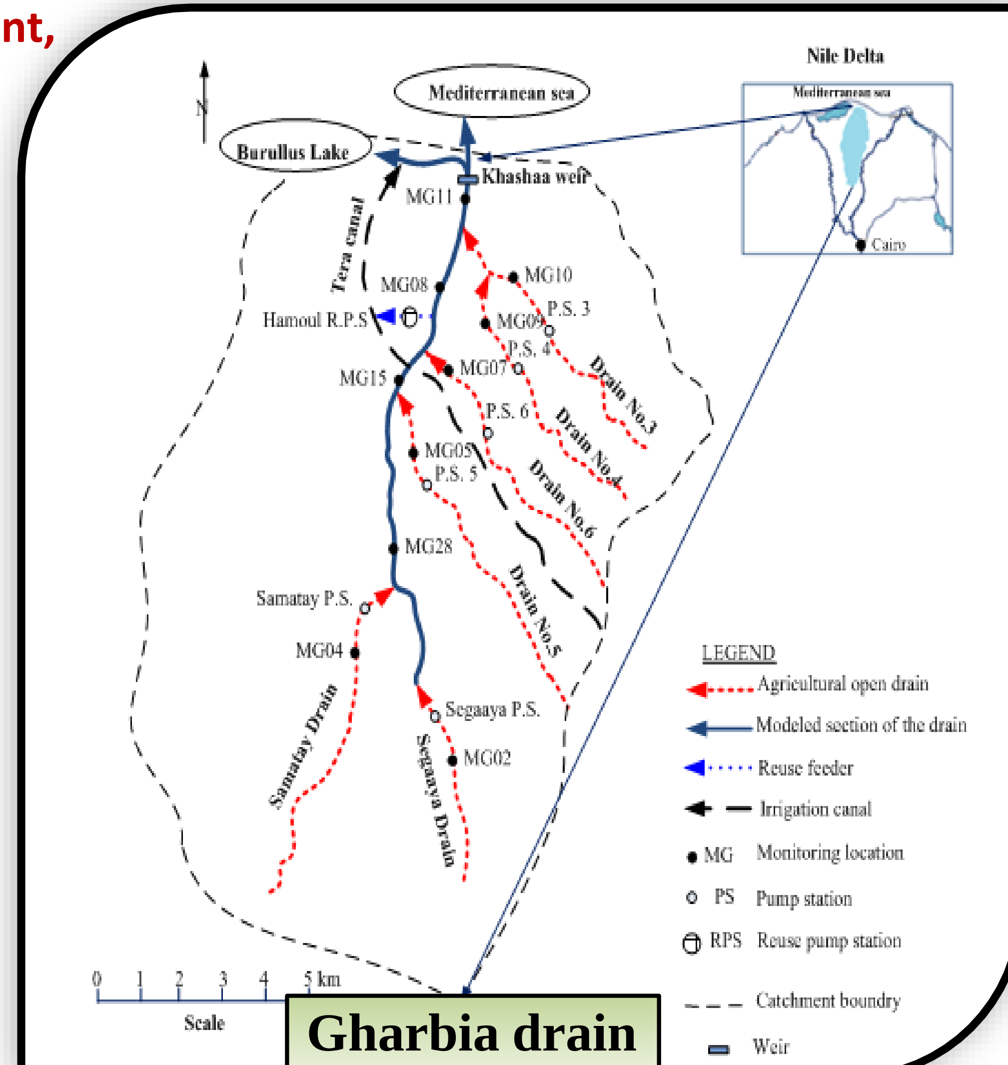
Environ Sci Pollut Res (2014) 21:8095–8111

4. A simulation-based suitability index of the quality and quantity of agricultural drainage water for reuse in irrigation (STE)

Ayman Khalifa Allam El-Khelaly Ph.D. Student,



- two years (August 2009 to July 2011)
- one year (August 2011 to July 2012)
- Based on Monte-Carlo simulation



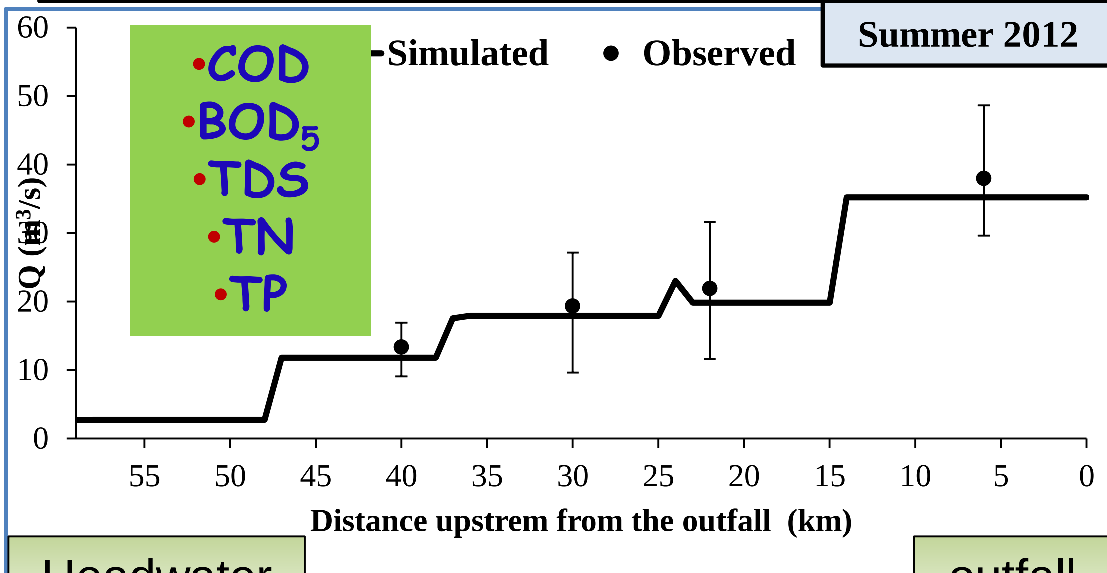
Current reuse is about 1 BCM

Declining water quality

Extremely shortage in irrigation water

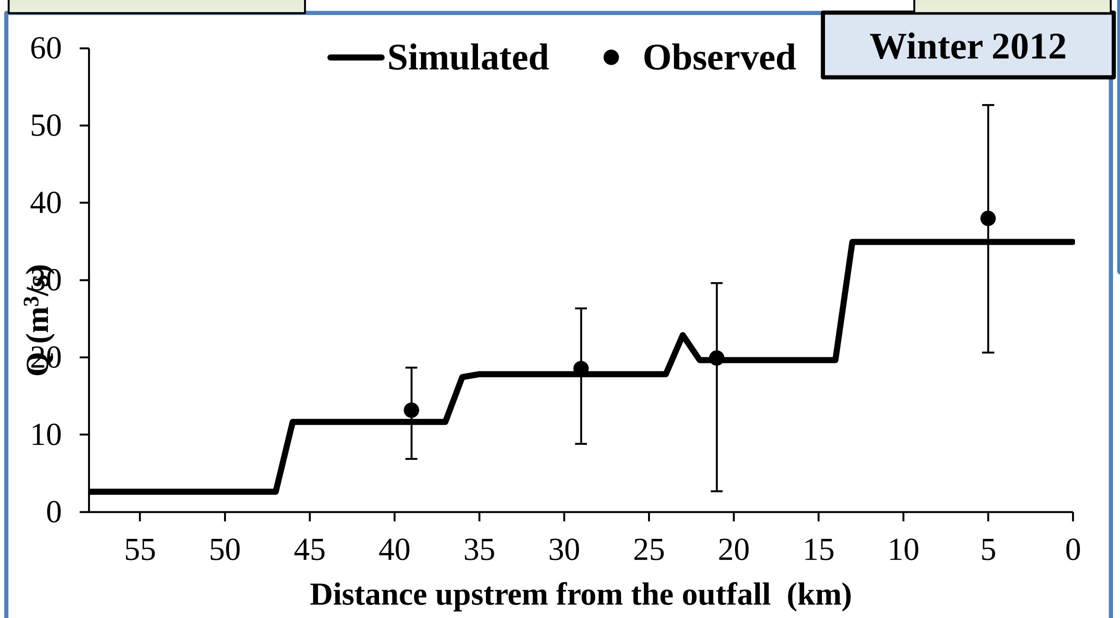
Simulation of ADW quality and quantity using QUAL2Kw

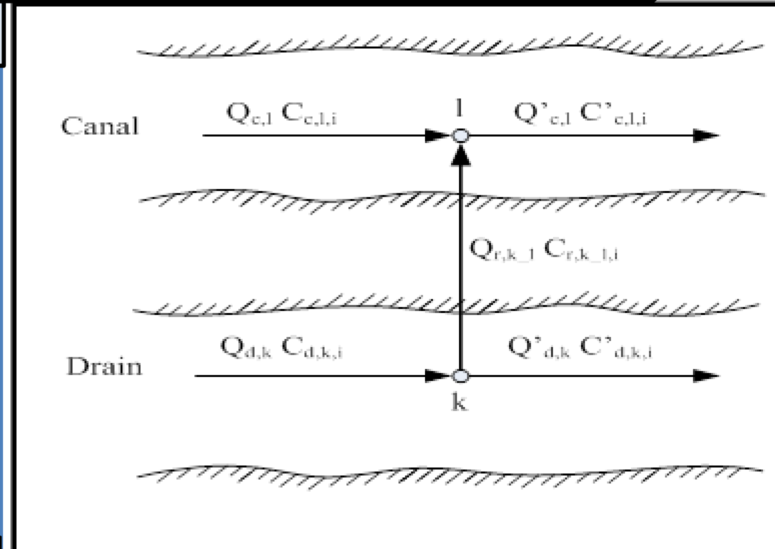
ADW quality and quantity Indexing



Headwater

outfall





- $I_{l,i} = \frac{Q_{r,k\_l}}{Q_{c,l}} = \frac{C_{s,i} - C_{c,l,i}}{C_{r,k\_l,i} - C_{s,i}}$

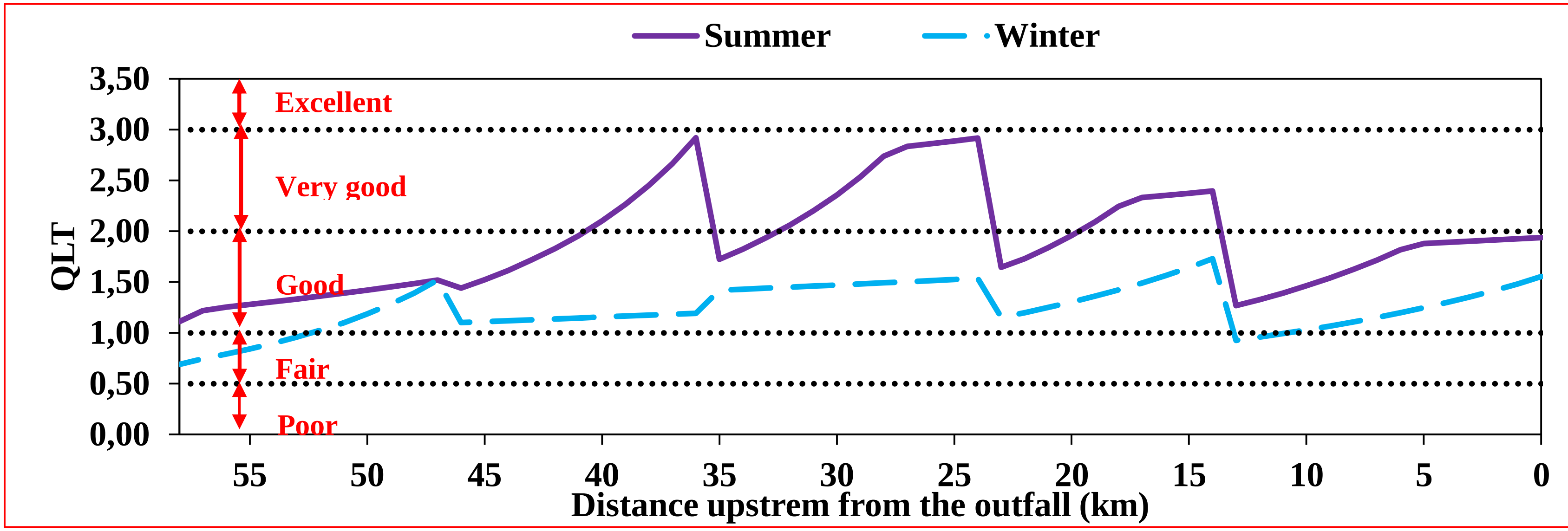
  Where $I_{l,i}$ is the sub-index for a constituent (i), at mixing point (l)
- $QLT_k = \min\{I_{i=1}, I_{i=2}, I_{i=3}, \ldots\ldots, I_{i=n}\}$

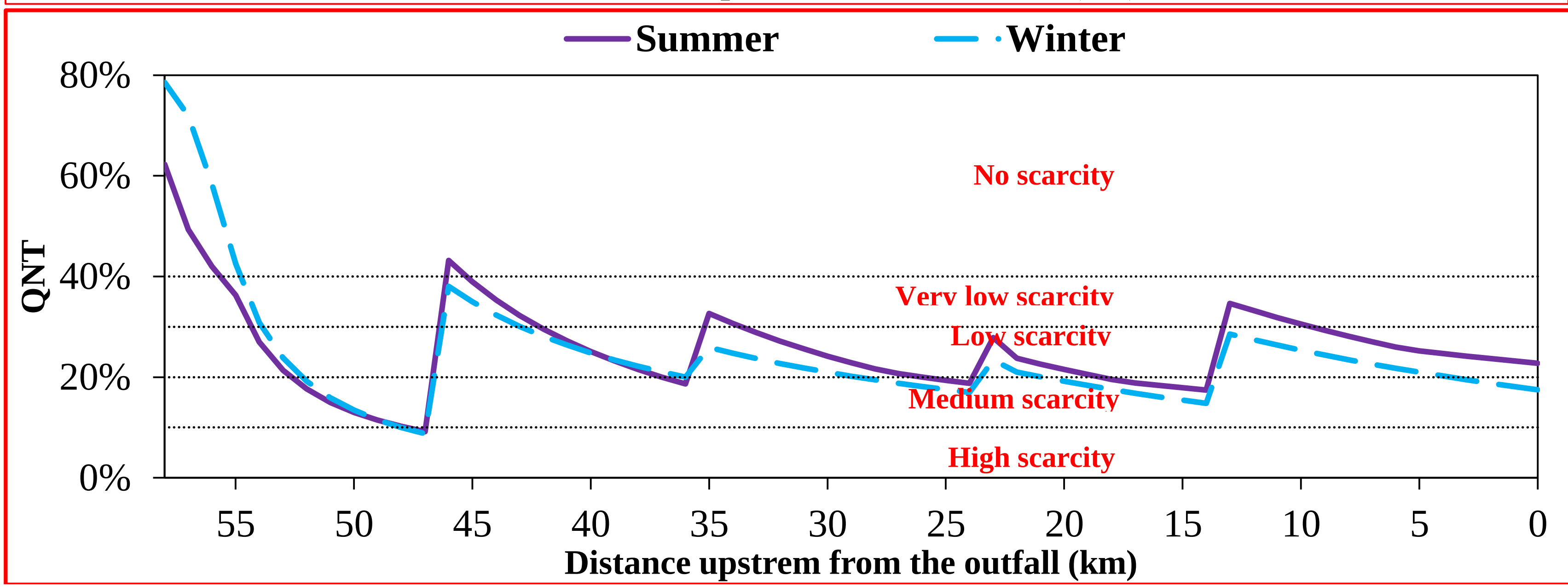
  Eq.1

- $Q_{r,k\_l,req.} = \frac{QLT_k Q_{Ireq.,l}}{(QLT_k + 1)}$

- $QNT_k = \frac{Q_{d,k}}{Q_{r,k\_l,req.}}$

  Eq.2





Science of the Total Environment 536 (2015) 79–90

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