



# Groundwater Economics in Arid Regions

**Mohamed Dawoud**

Water Resources Advisor,  
Environment Agency – Abu Dhabi, UAE



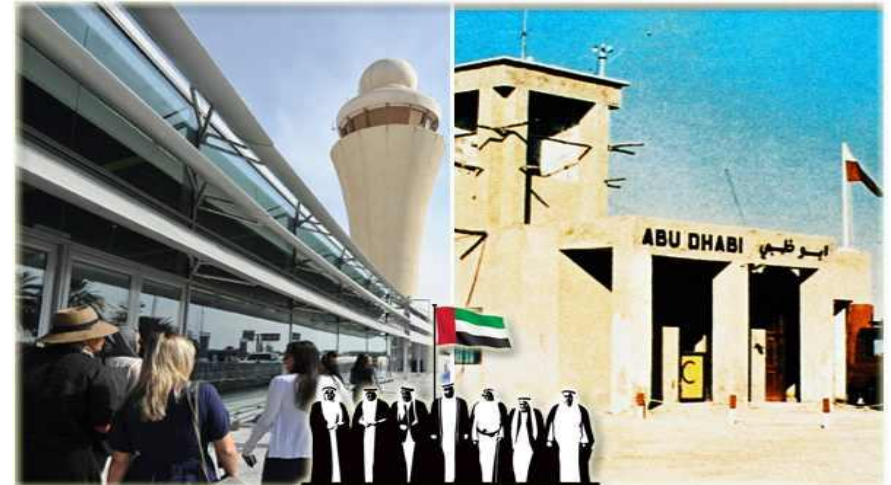
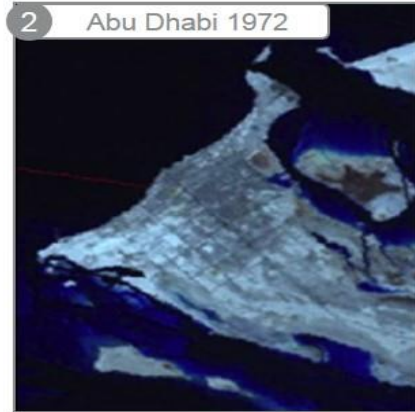
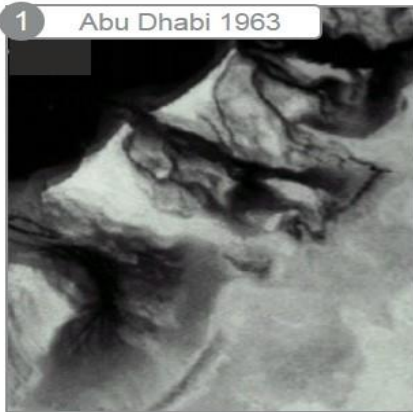
# Overview

- Introduction
- Groundwater Use
- Hydrogeology of Abu Dhabi
- Groundwater Salinity
- Hydrogeological Considerations Relevant GW Economic Assessment
- Comparison of Optimal and Inefficient Time Paths of Groundwater Extraction
- Conceptual diagram of groundwater valuation model
- Marginal groundwater value (in AED/m<sup>3</sup>)
- Final Remarks

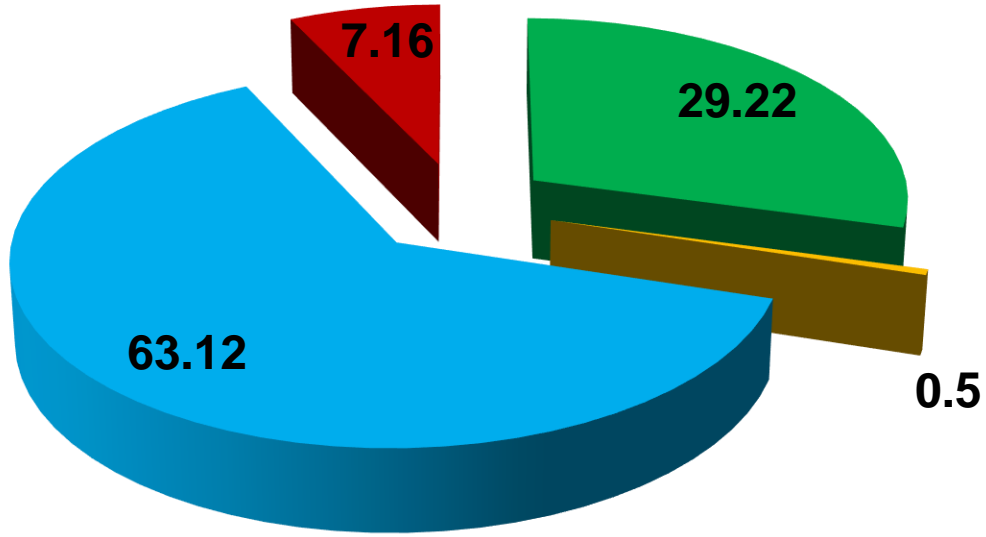
# Groundwater History



# Rapid Development Impact on Groundwater



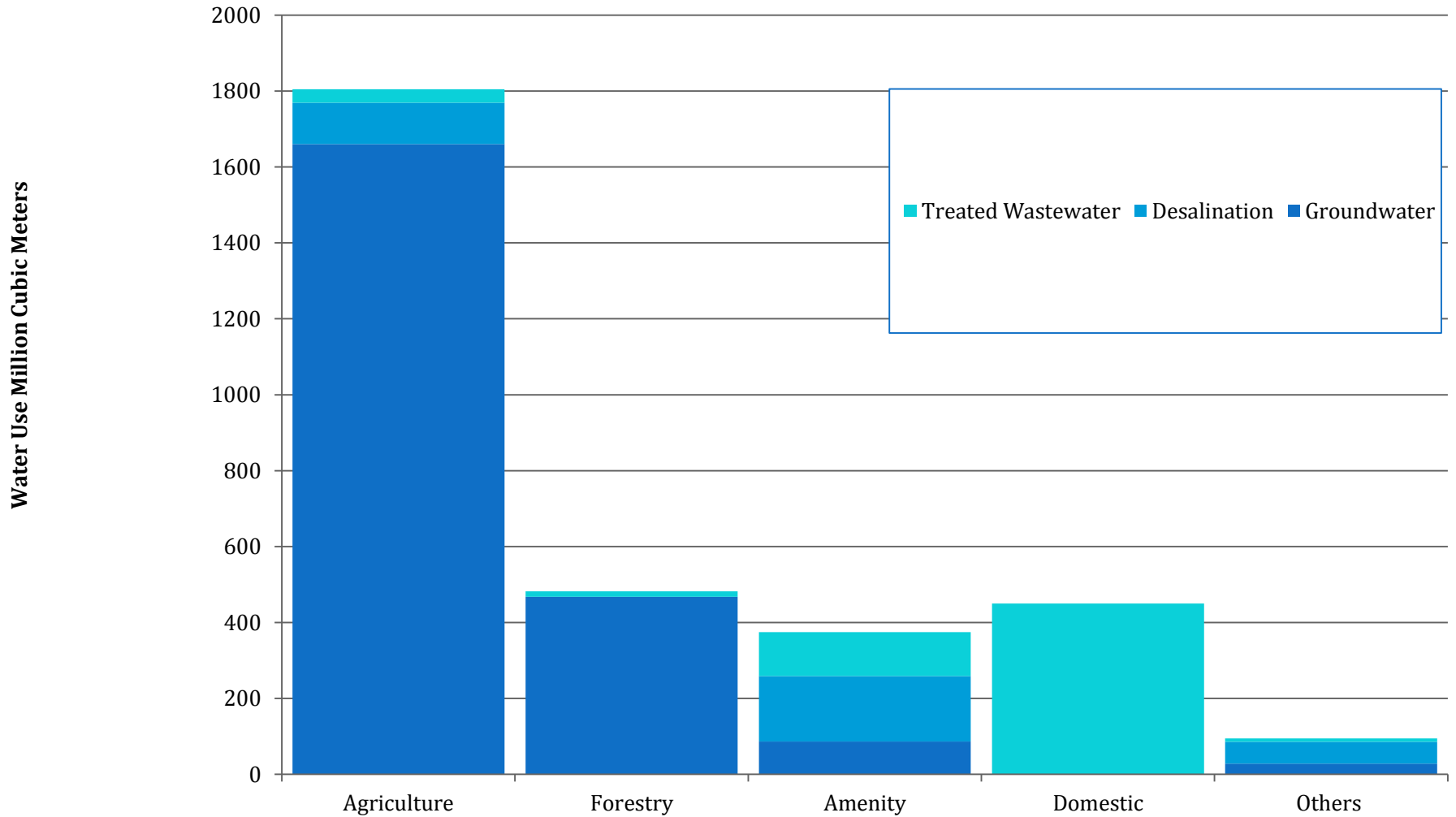
# Introduction



- مياه التحلية
- المياه الجوفية العذبة
- المياه الجوفية عالية الملوحة
- مياه الصرف الصحي المعالج



# Groundwater Use

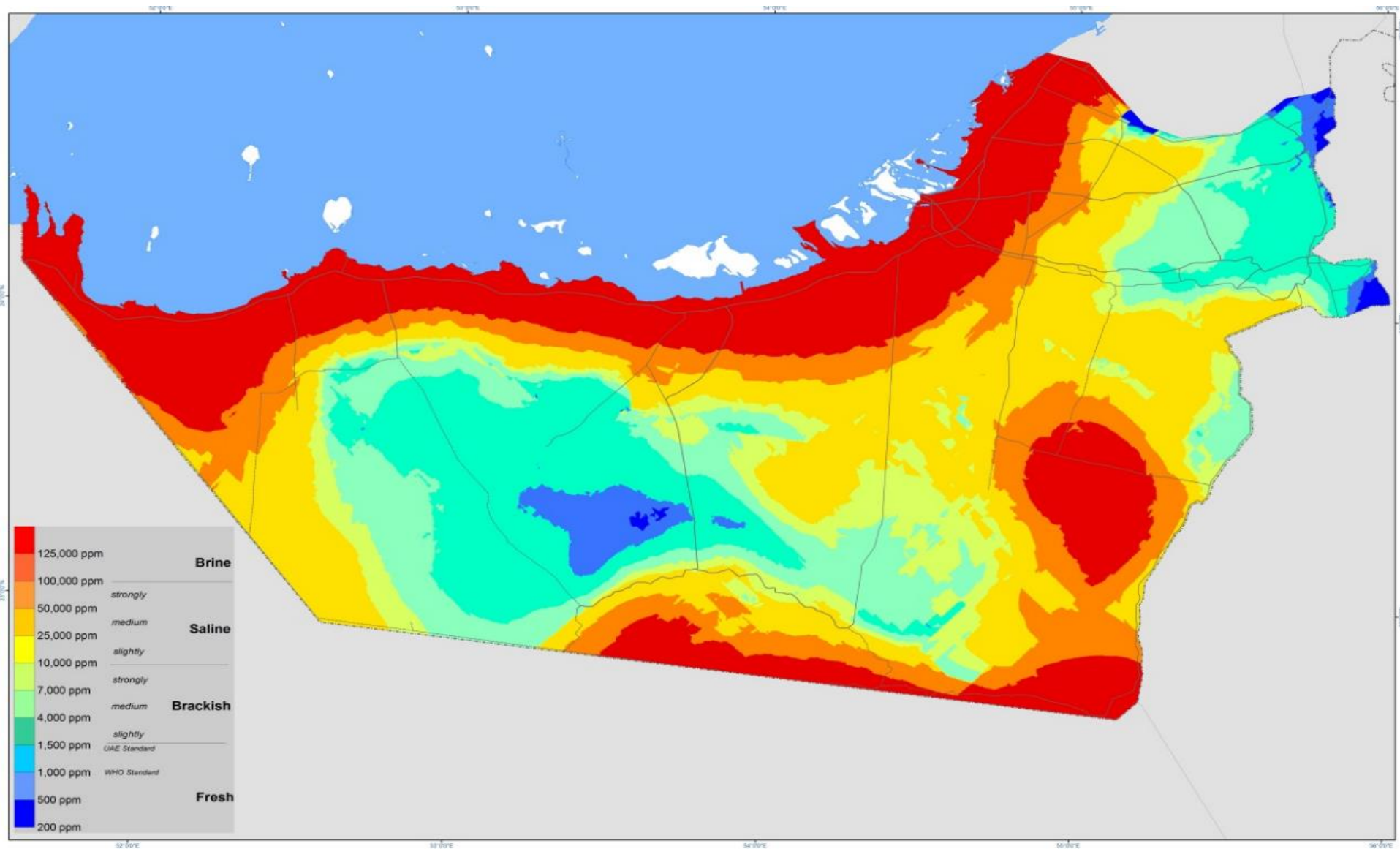


# Hydrogeological Map



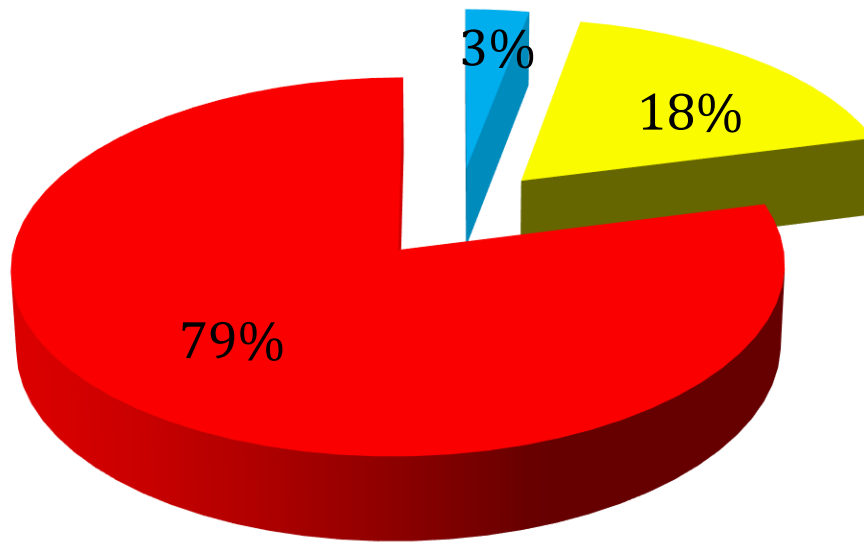
- Quaternary Aquifer / Aquitard directly underlain by the Lower Fars Formation as basal unit (Regional Aquiclude)
- Quaternary Sand and Gravel Aquifer underlain by the Upper Fars Formation as basal unit
- Coastal and Inland Sabkhas (salt-flats)
- Baynunah Formation: Continental Upper Miocene Sandstones and Conglomerates with gypsiferous cap-rocks that form small mesas
- Quaternary Sand and Gravel Aquifer east of Jebel Hafit (Al Jaww Plain) underlain by the Upper Fars and Lower Fars Formations as basal unit
- Lower Fars Formation (Miocene mudstones and evaporites) outcropping, or near surface
- Quaternary Sand and Gravel Aquifer underlain by tectonically emplaced dark Marlstones and Shales as main basal unit with occasional limestone layers
- Limestone Ridges and Mountains
- Salt Diapir (Cambrian)

# Groundwater Salinity





# Groundwater Quality and Its Economic Impacts



■ Fresh



# Groundwater Use in Agriculture

**Agriculture is the largest source of groundwater consumption in Abu Dhabi by a wide margin, accounting for roughly 1.7 billion m<sup>3</sup> per year.**



# Groundwater Use in Amenity and Landscaping

In our model, total amenity consumption of groundwater is restricted to certain zones, and the total is capped at 51 million m<sup>3</sup> per year, consistent with observed water resource usage rates.



# Groundwater Changes and threat affecting its economic value

Aridity and Scarcity

Institutional and  
Legal Fragmentations

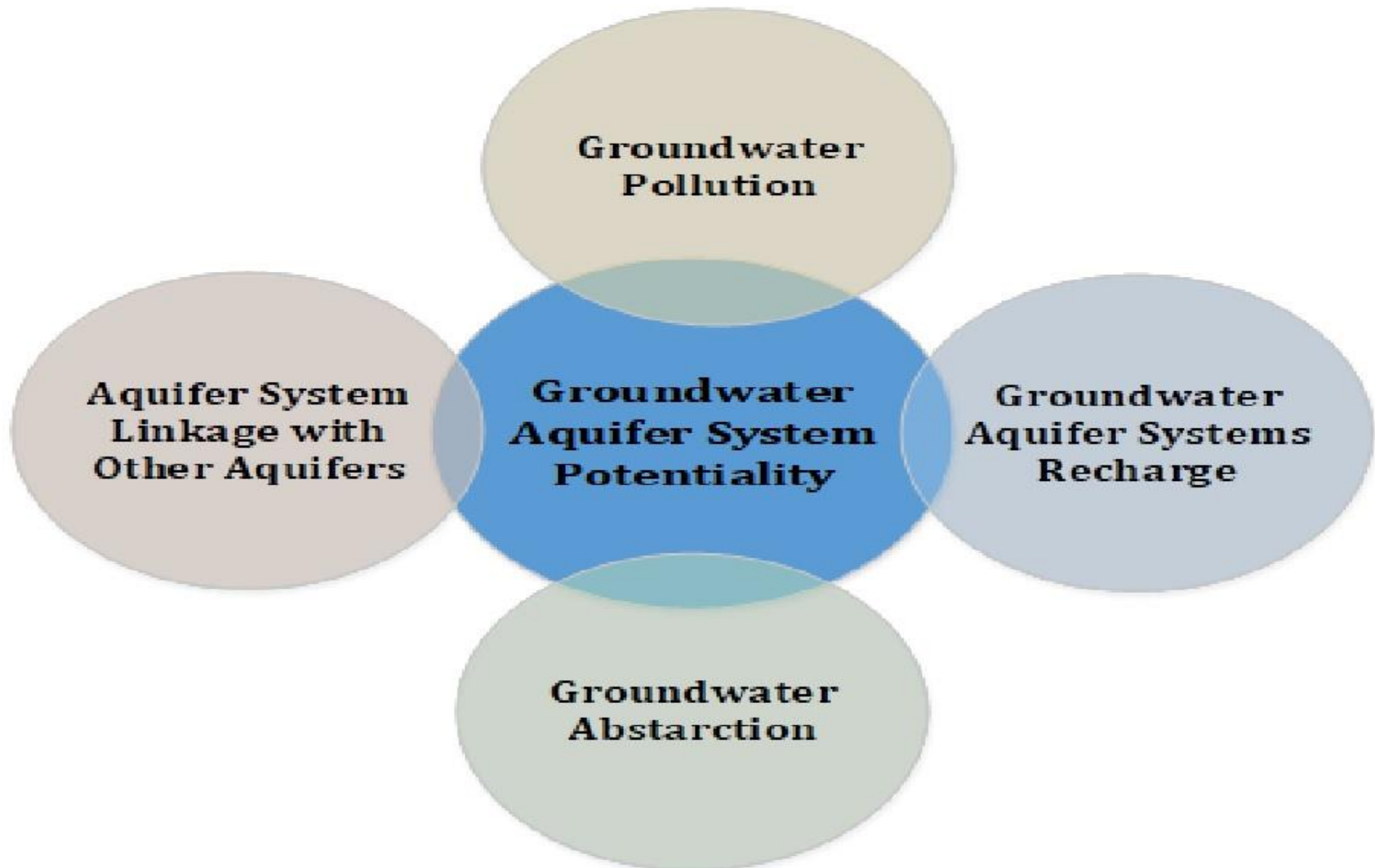
External Threats

Internal Threats

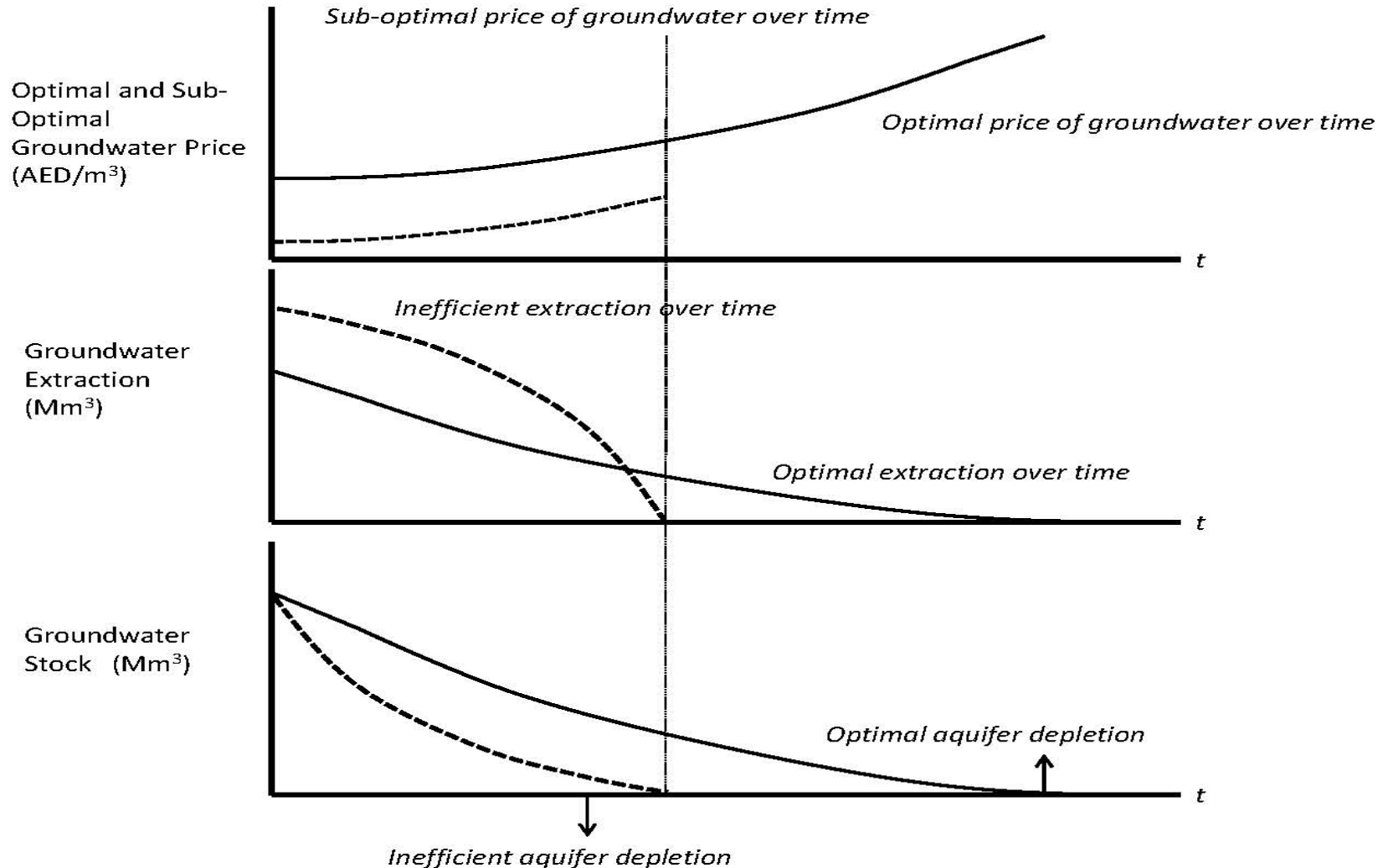
Climate Change



# Hydrogeological Considerations Relevant GW Economic Assessment



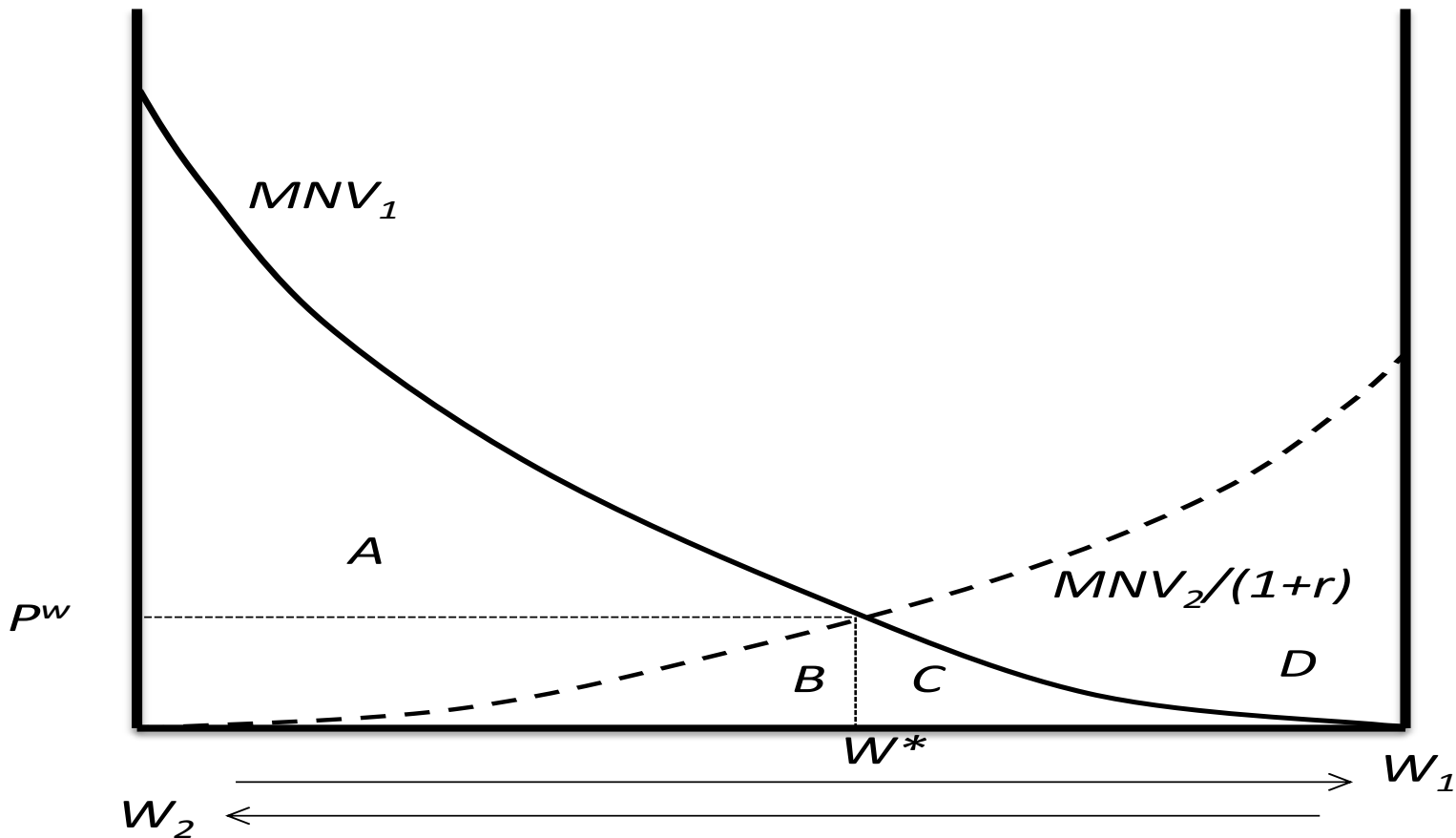
# Comparison of Optimal and Inefficient Time Paths of Groundwater Extraction



# Conceptual diagram of groundwater valuation model

AED Value of Water  
in Period 1

AED Value of Water  
in Period 2



# Groundwater Economic Valuation

## Total Economic Value (VET)

### Use Value

Market  
Use  
Value  
(Agriculture)

Non-Market  
Use  
Value  
(Forests,  
Amenities)

### Non-Use Value

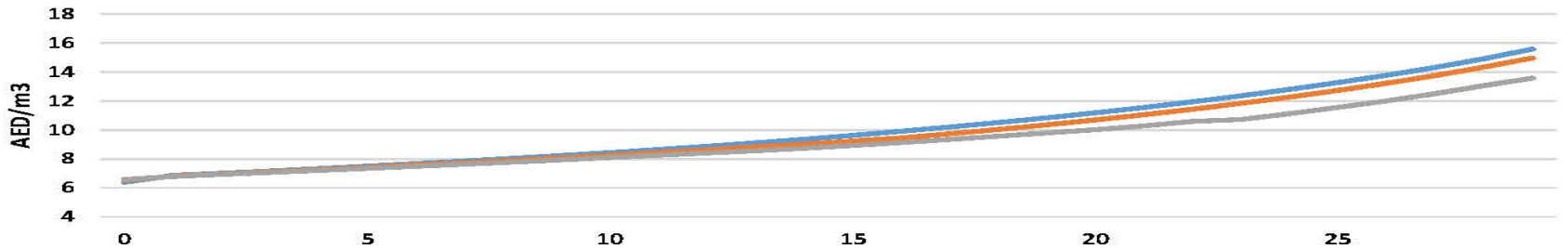
Option  
Value  
(Strategic  
Water  
Reserve)

Existing  
Bequest  
Value

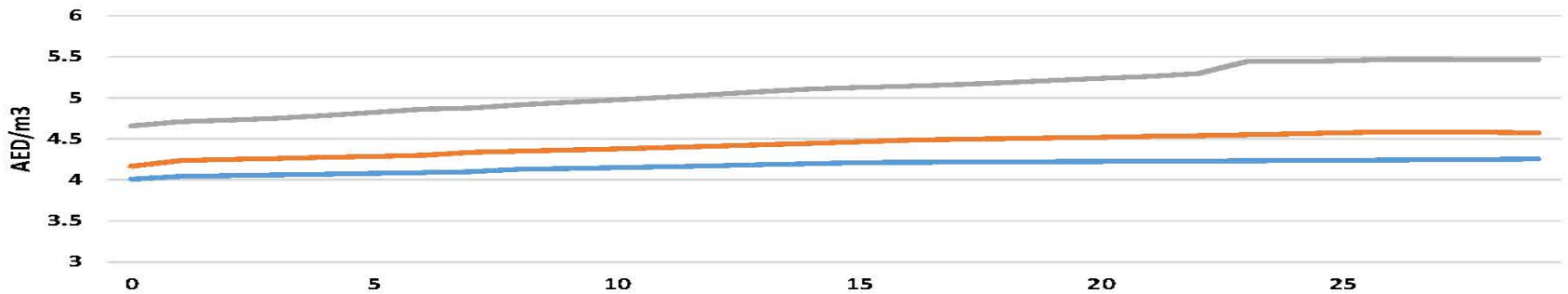


# Marginal groundwater value (in AED/m<sup>3</sup>)

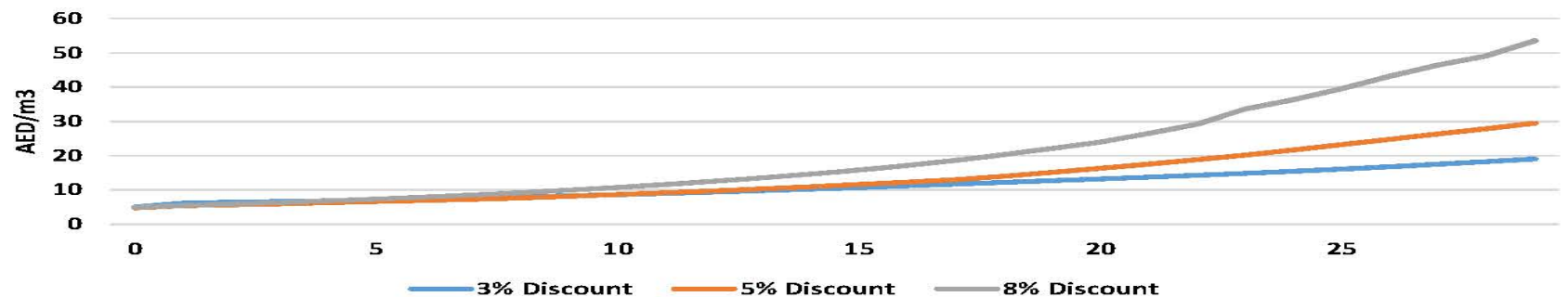
## Average Value of Groundwater Consumption



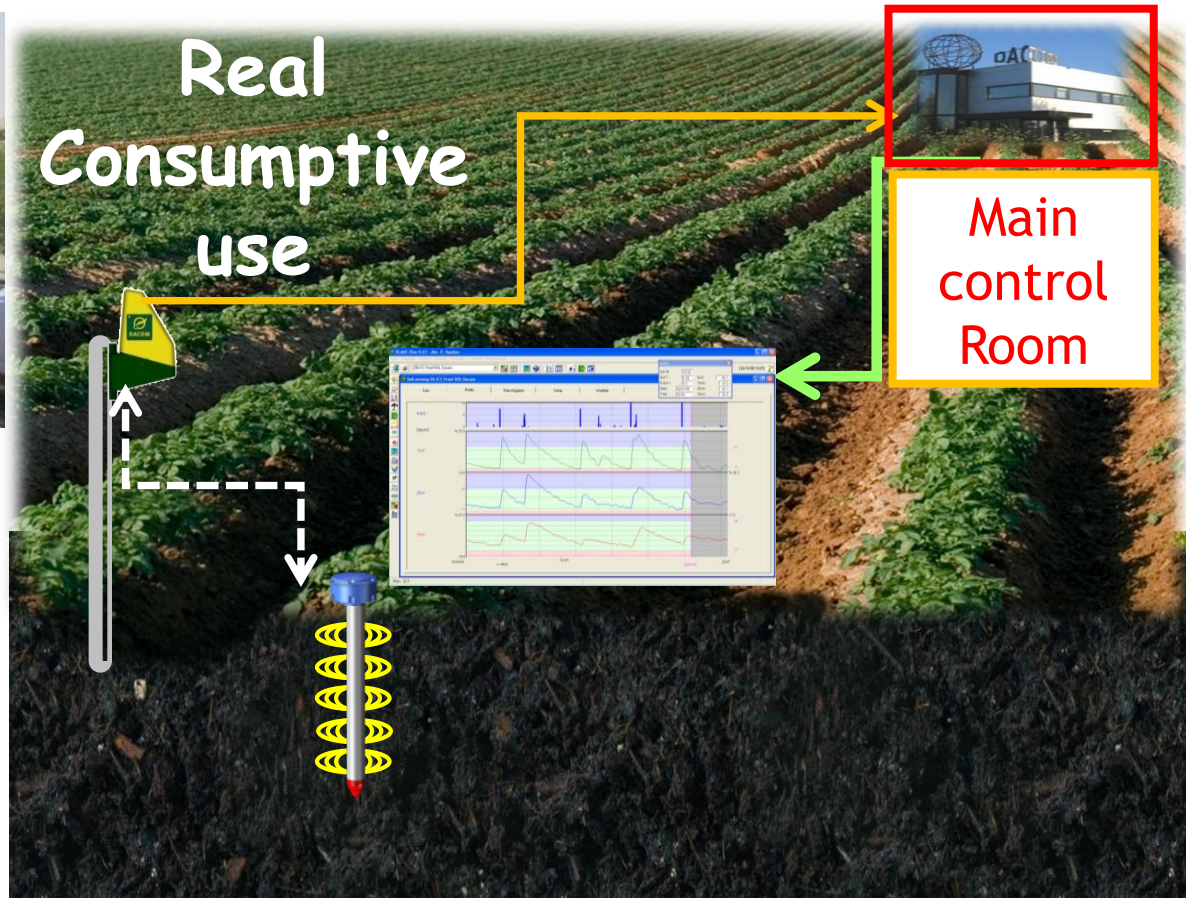
## Average Consumption Costs



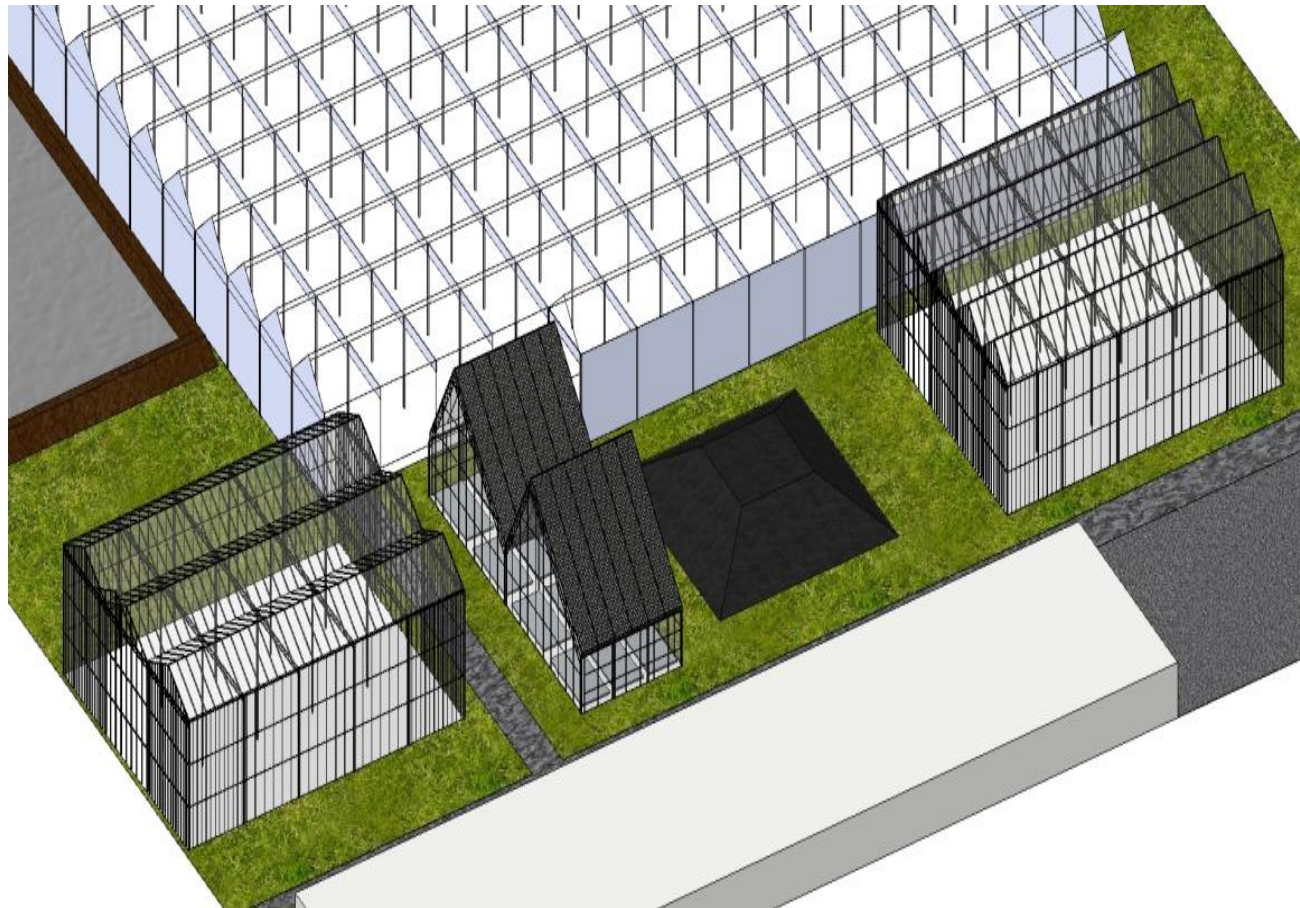
## Marginal Value of Groundwater



# Improving irrigation efficiency impact on GW economic value



# Improving irrigation efficiency impact on GW economic value



# Using small scale solar powered desalination units in farming



# Final Remarks

Groundwater is a vital resource in arid region such as Abu Dhabi and calculating the groundwater value can help for a better understanding and sustainable use of this resource. Many actions should be taken by the government to sustain these resources in the future such as:

- Future agricultural policy including prices and costs
- Estimating food security benefits of irrigated agriculture
- Future non-market values for forest ecosystem services
- Future population growth rates and composition
- Climate change impacts on the groundwater resources
- Reform the legal and institutional water sector framework including groundwater regulation and legislations
- Infrastructure investment options
- Greenhouses, more efficient irrigation systems, and new innovative technologies in agriculture sector etc.