Water metabolism in North African cities: methods and some preliminary results

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GRATS SEMINAR

UAB Campus, Cerdanyola del Vallès, 10th-11th June 2013

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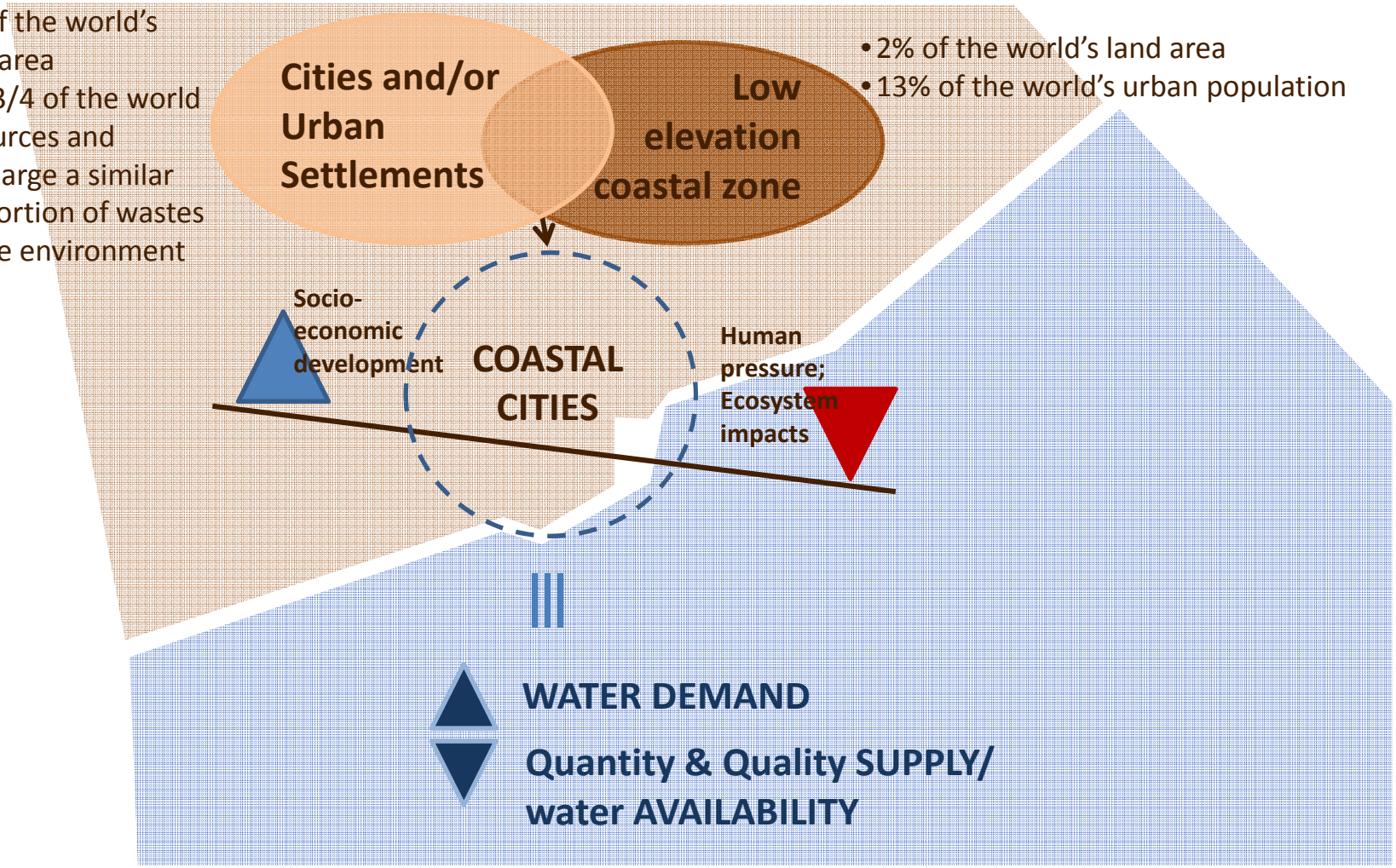
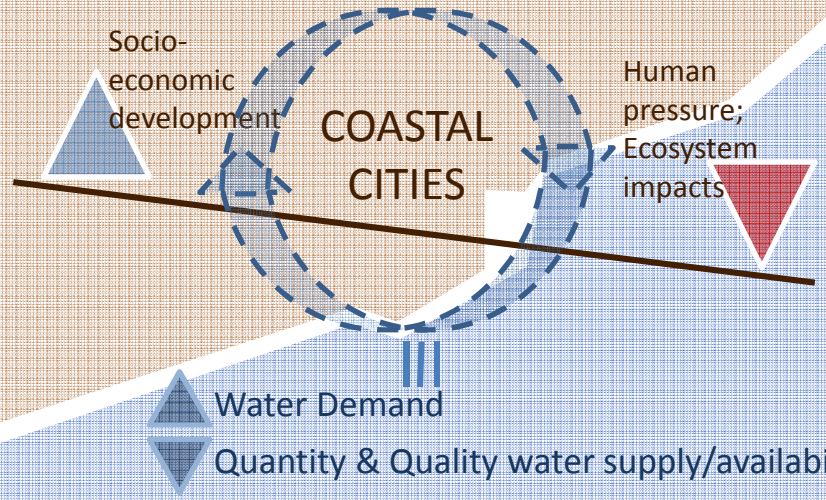
- 2% of the world's land area
- Use 3/4 of the world resources and discharge a similar proportion of wastes to the environment



- 2% of the world's land area
- 13% of the world's urban population

NORTH AFRICA:

- **70-90% of the population is concentrated along the narrow coastal strip of the Mediterranean shoreline**



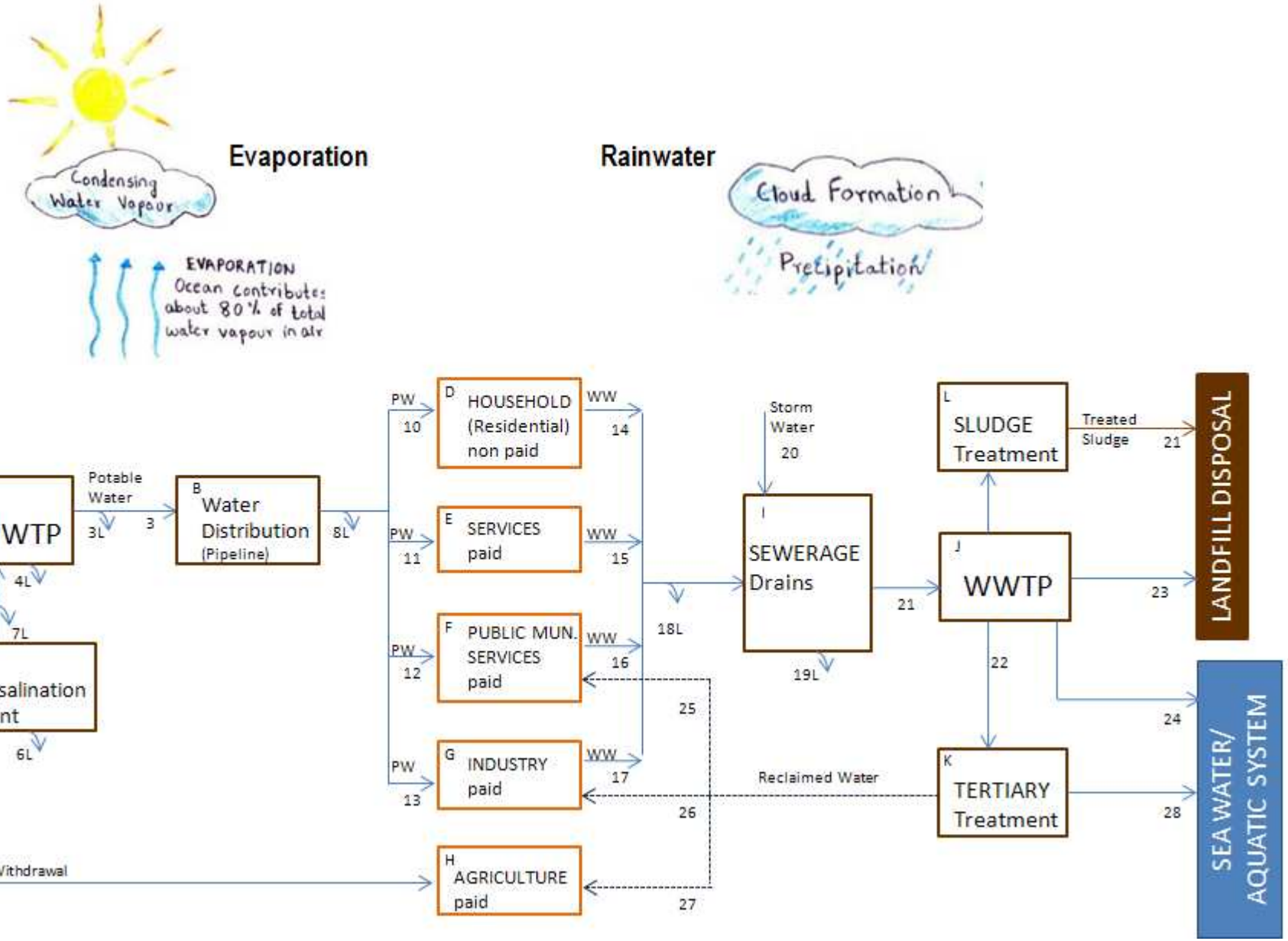
How to increase socially just and sustainable use of water resources ?

NORTH AFRICA:

- **Yearly average per capita renewable water availability is of less than 950m³**
- **650m³/cap/yr. by 2025 (climate change studies)**
- **One of the most water-scarce and water-stressed regions of the world**

- To assess the sustainability of water use by Northern Africa coastal cities
  - To develop a better understanding of NA cities functions, state and needs in terms of water resources, by defining and quantifying the physical flows and stocks of water that characterize the urban coastal system
  - To apply the described flow-system to the city of Nador in Morocco (case study)

- Conceptual framework: **Urban metabolism** (biophysical-quantitative approach)
- Methodological framework: **Material Flow Accounting and Analysis**
  - acceptance of "material balance" principles for the "resource system modelling"
  - tools and methods within MFAA framework: Material Flow Analysis (MFA); Substance Flow Analysis (SFA); Physical Input-Output table (PIOT)
- Scale: Local/Regional_City flow analysis assessment
  - studies at local/regional scale use previously published methods with necessarily required modifications and improvements

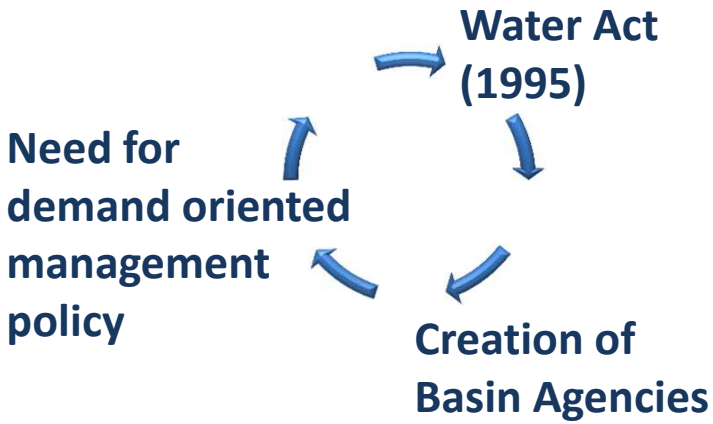

Evaporation
Condensing Water Vapour
EVAPORATION
Ocean contributes about 80% of total water vapour in air
Rainwater
Cloud Formation
Precipitation
Water Inflows
1L
1
Local WWith
2L
2
A
PWTP
3L
Potable Water
3
B
Water Distribution (Pipeline)
8L
4L
7
7L
C
Desalination Plant
Sea Water
5L
5
6L
PW
10
D
HOUSEHOLD (Residential) non paid
WW
14
PW
11
E
SERVICES paid
WW
15
PW
12
F
PUBLIC MUN. SERVICES paid
WW
16
PW
13
G
INDUSTRY paid
WW
17
Local Water Withdrawal
9L
9
H
AGRICULTURE paid
18L
Storm Water
20
I
SEWERAGE Drains
19L
21
25
26
27
Reclaimed Water
L
SLUDGE Treatment
Treated Sludge
21
J
WWTP
23
22
24
K
TERTIARY Treatment
28
LANDFILL DISPOSAL
SEA WATER/ AQUATIC SYSTEM

Morocco

Water DEMAND

water AVAILABILITY
(Qty & Qlty)

≡ **Water CRISIS**



- Total water inflow ≡ 29Km^3 19Km^3 (15Km^3 SW + 4Km^3 GW) technically and economically exploitable + 7Mm^3 Desalinated
- Per capita availability: 2.560m^3/cap/y (1960) 720m^3/cap/y (2010) (E) 520m3/cap/y (2020)
- Total water demand ≡ 13Km^3 80% used for irrigation and the remaining 20% for other uses (drinking, industry)
- Sanitation and pollution/contamination is the main problem together with informal settlements
  - Sewage network system (relatively good)
  - Waste water treatment insufficient (35 WWTP)

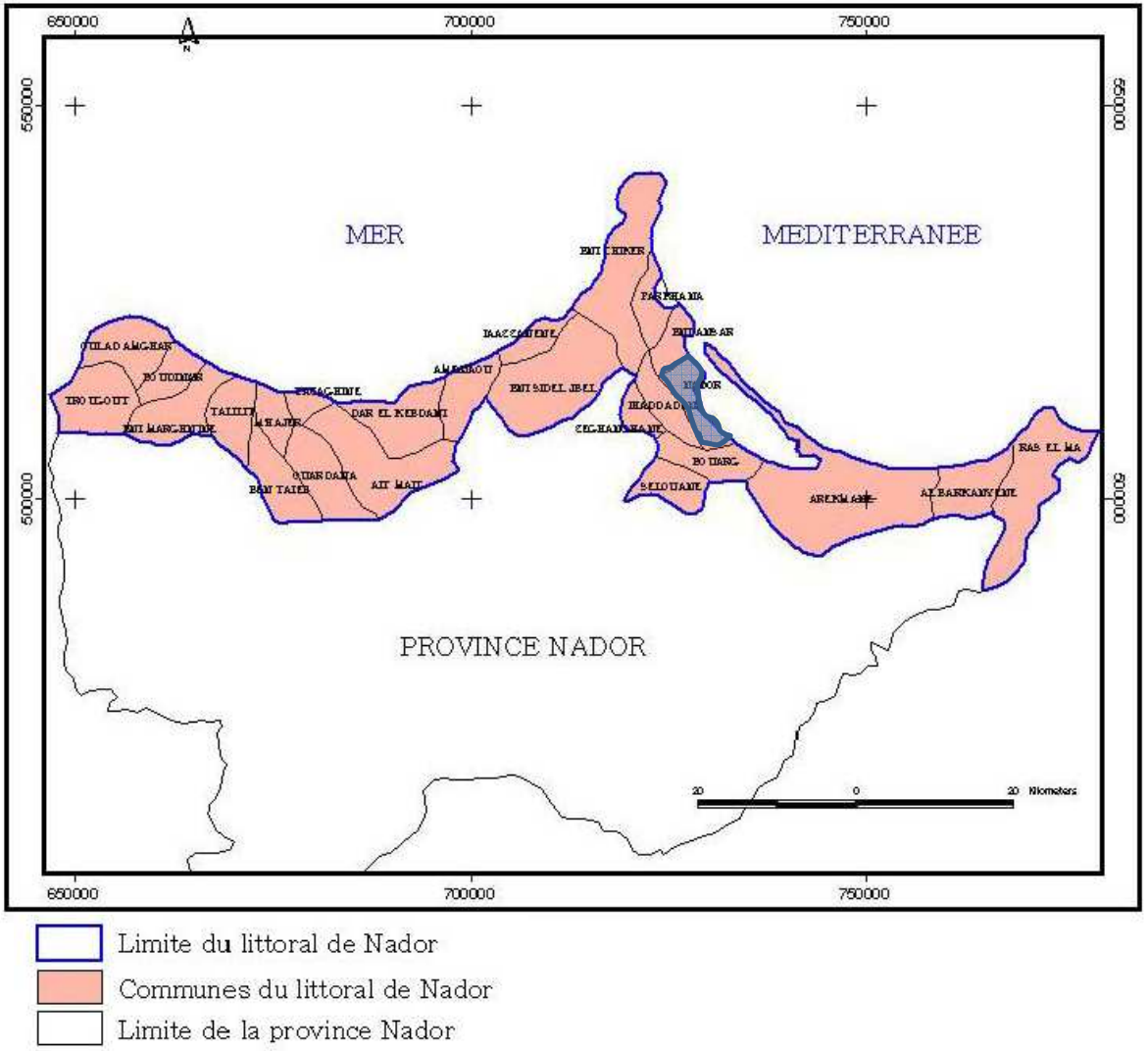
Nador's Location

Country: Morocco

Region: Oriental: *1 Préfecture, 6 Provinces;*

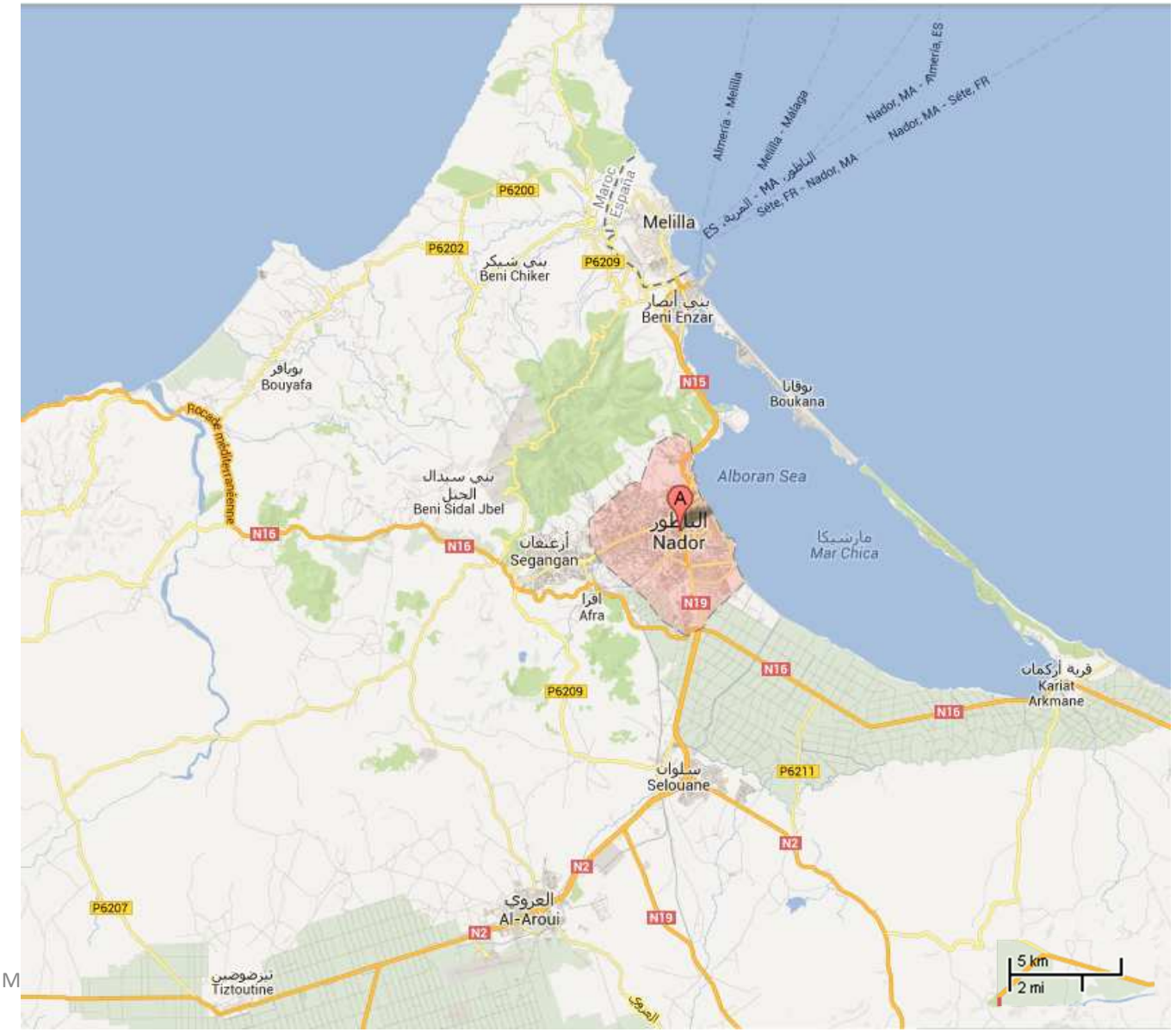
Province: Nador

City: Nador



Source: (Khattabi, et al., 2007).

Nador (Morocco) Case Study



Maps with no original scale

Nador

- Drinking water supply ≡ 13Mm^3/year:
  (Nador province, 2007)
  - Mohammed V and Mecheraa Hammadi Dams
  - Moulouya river
  - Local groundwater sources (aquifers Bouareg-Gareb)

Nador City Situation

- 74,7% of Nador's households connected to the water supply network (2007)
- 64.7% Nador's households connected to the sewer network system (2007)
- Still some informal settlements persist in the peripheries of Nador city
- Sanitation is the main problem together with high pollution levels in Mar Chica lagoon

RADEEN projected investments 2006-2010

- *Extension of Nador's drinking water network to ensure 100% city supply*
- *Rehabilitation and enlargement of the sewage network to informal settlements*
- *Rehabilitation of the waste water treatment plant and construction of a 2nd WWTP (started operating in may 2010)*
- *Construction of a desalination plant to be operative in 2015*

- The methodological framework provided by MFA enhances the scope for application of environmental accounting and systems analysis at the local scale.
- Nador's limited water resources, in contrast with its level of socioeconomic development, indicates the need to rationalize water resources, increase recycling and reuse, protect groundwater quality and prevent water pollution.
- The study of UM in Nador may help to understand the water flows of the city and their social and environmental fairness.