Water reuse for forestry and agroforestry irrigation

Turning risk into value

Dr. Akiça Bahri
National Agricultural Institute of Tunisia (INAT)

Irrigating Forests with Wastewater – Natural and Effective Water Treatment?
Stockholm, 27 August 2017

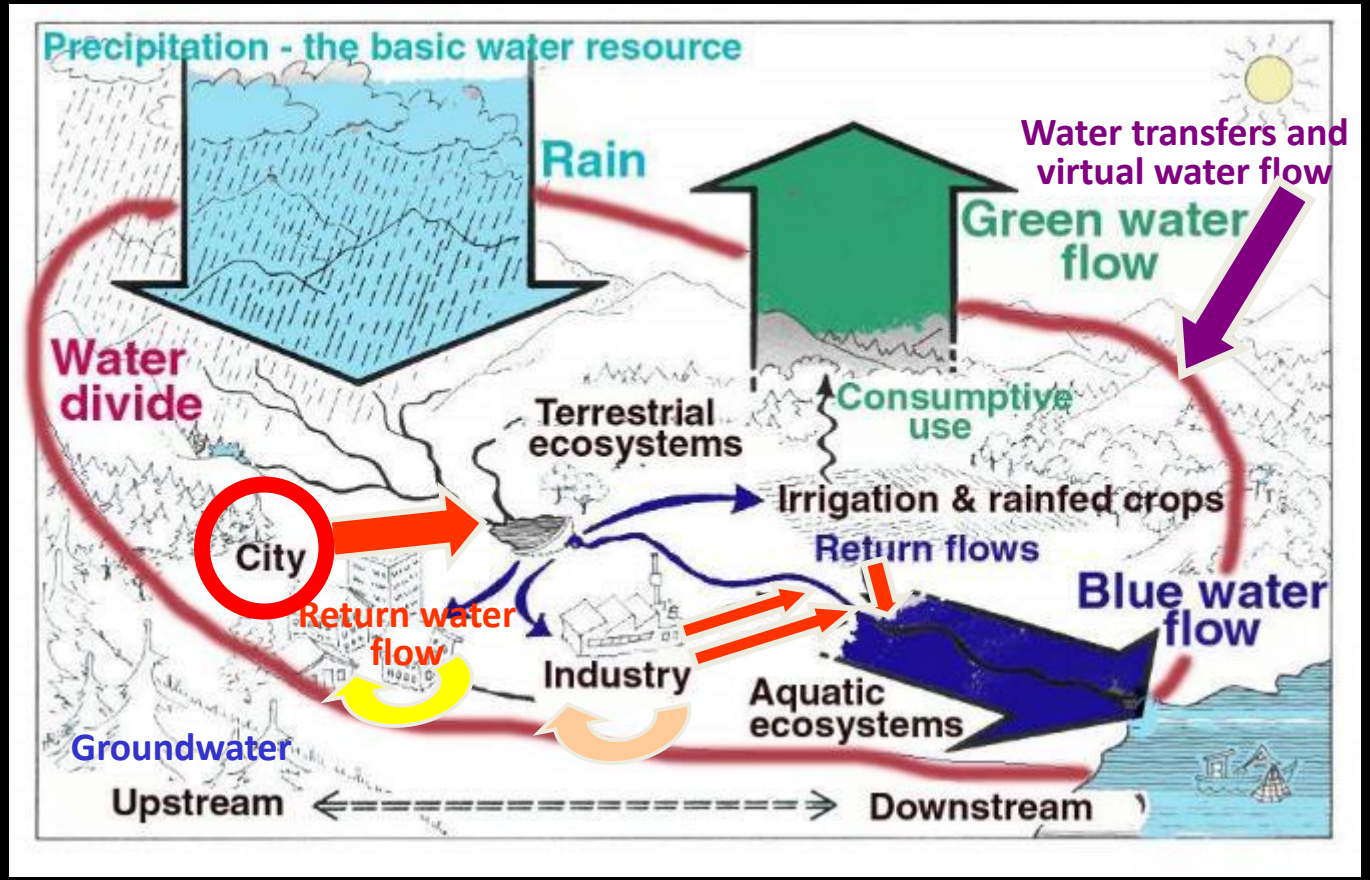
Untapped potential for resource recovery and reuse from wastewater

330 km^3/year of municipal WW generated in the world (Flörke et al., 2013) that could theoretically:

- Irrigate more **than 40 million hectares (**8000 m^3/ha/yr) (FAO 2012) – 15% of all irrigated land
- Provide 'free' fertilizer application in the order of **322 kg N/ha/yr and 64 kg P/ha/yr**
- Provide **electricity for about 130 million households** (3500 kWh/HH) (World Energy Council 2013)

Source: Wilchens et al. (2015)

The Urban Catchment Perspective



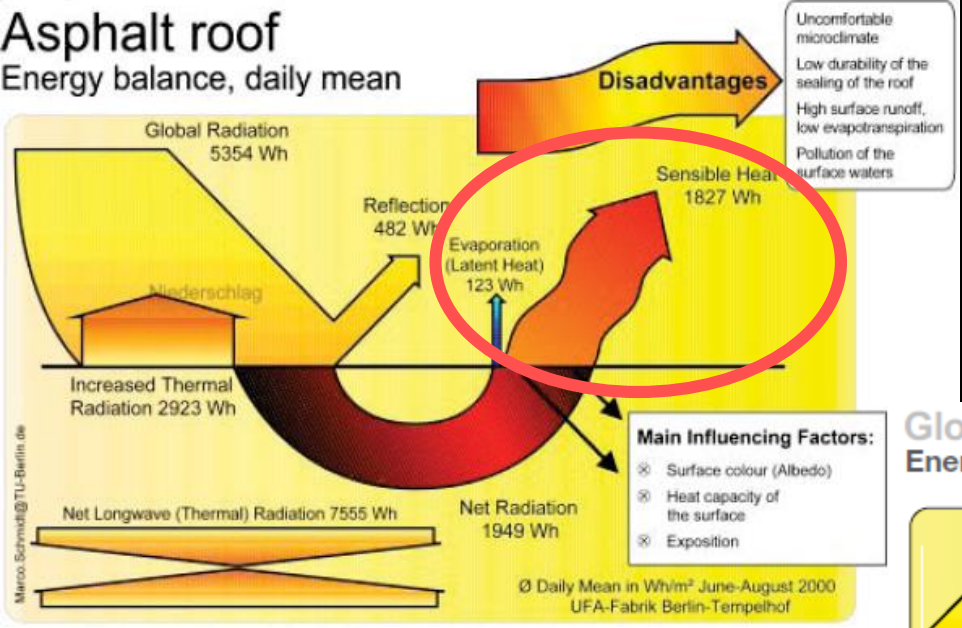
Source: Adapted from Falkenmark (2002)

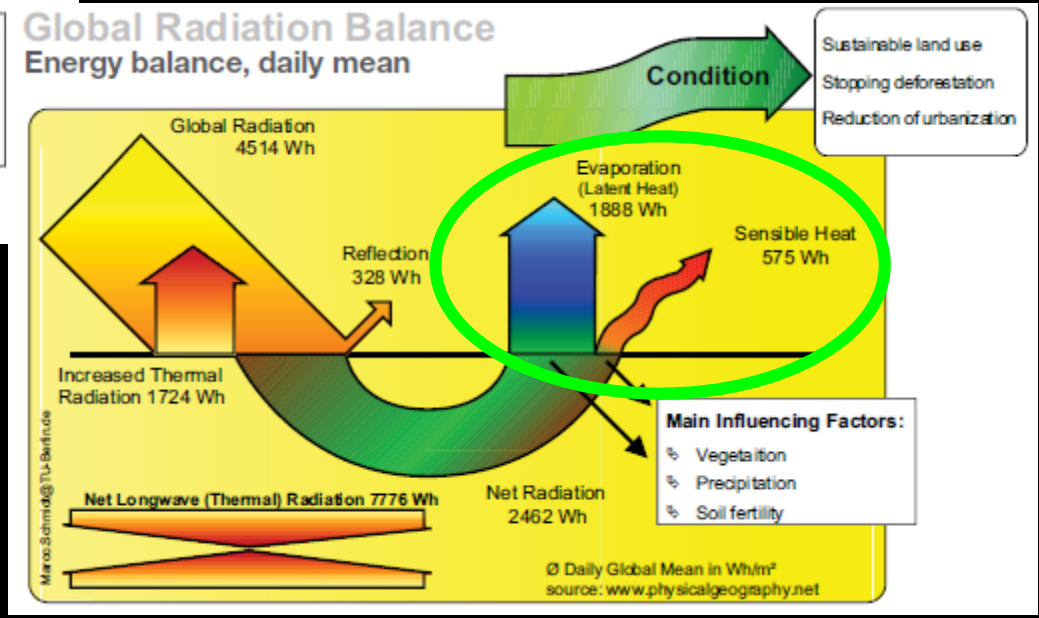
Impact of global change in land use

- Global development characterized by:
  - Daily deforestation rates of 350 km^2
  - Daily desertification process of 300 km^2
  - Daily loss of agricultural areas to urbanization of about 150 km^2
- The global change in land use and its impact on the hydrology reduces evaporation and precipitation rates and releases heat
- Lack of vegetation, absence of unpaved soils and impermeable surfaces like roofs and streets convert most of the net radiation from the urban setting to sensible heat rather than evaporation

Source: Schmidt (2009)

Radiation and hydrology of urbanized landscapes



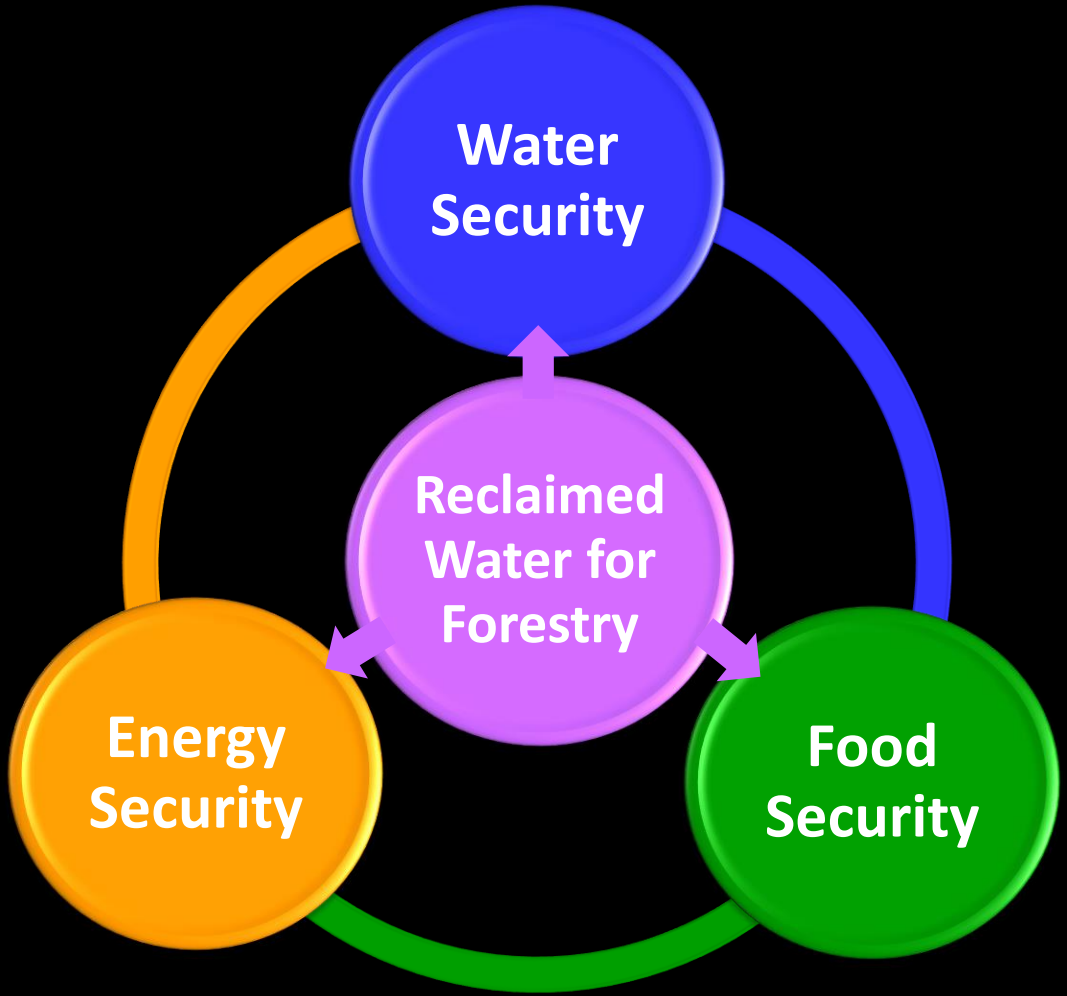


Source: Schmidt (2005, 2009). Energy data based on www.physicalgeography.net

Sustainable land use

- Fundamental changes in land use needed
- Greening the cities with forest plantation irrigated with RW such that solar radiation is converted to ETP, C is stored and sequestered and atm. CO_2 is reduced
- Soil fertility, especially the storage capacity for water, is essential for the small water cycle
- Wastewater management needs to be shifted from sewer systems to evaporative cooling and vegetation
- Forestry can improve the urban and peri-urban environments in arid and semi-arid regions through wastewater irrigation of forests, forest plantations, greenbelts and amenity trees
- Need to rethink urban planning and wastewater management

Source: Adapted from Schmidt (2009)


Water Security
Reclaimed Water for Forestry
Energy Security
Food Security

Water reuse for forestry and agroforestry

- Objective of WWT still largely disposal-oriented
- Need to change the focus of wastewater management to evapotranspiration rather then disposal
- Productive and purification aspects of water reuse recently emphasized
- Prevailing tendency allocated to agricultural water reuse
- No detailed standards and guidelines for trees and forest plantations

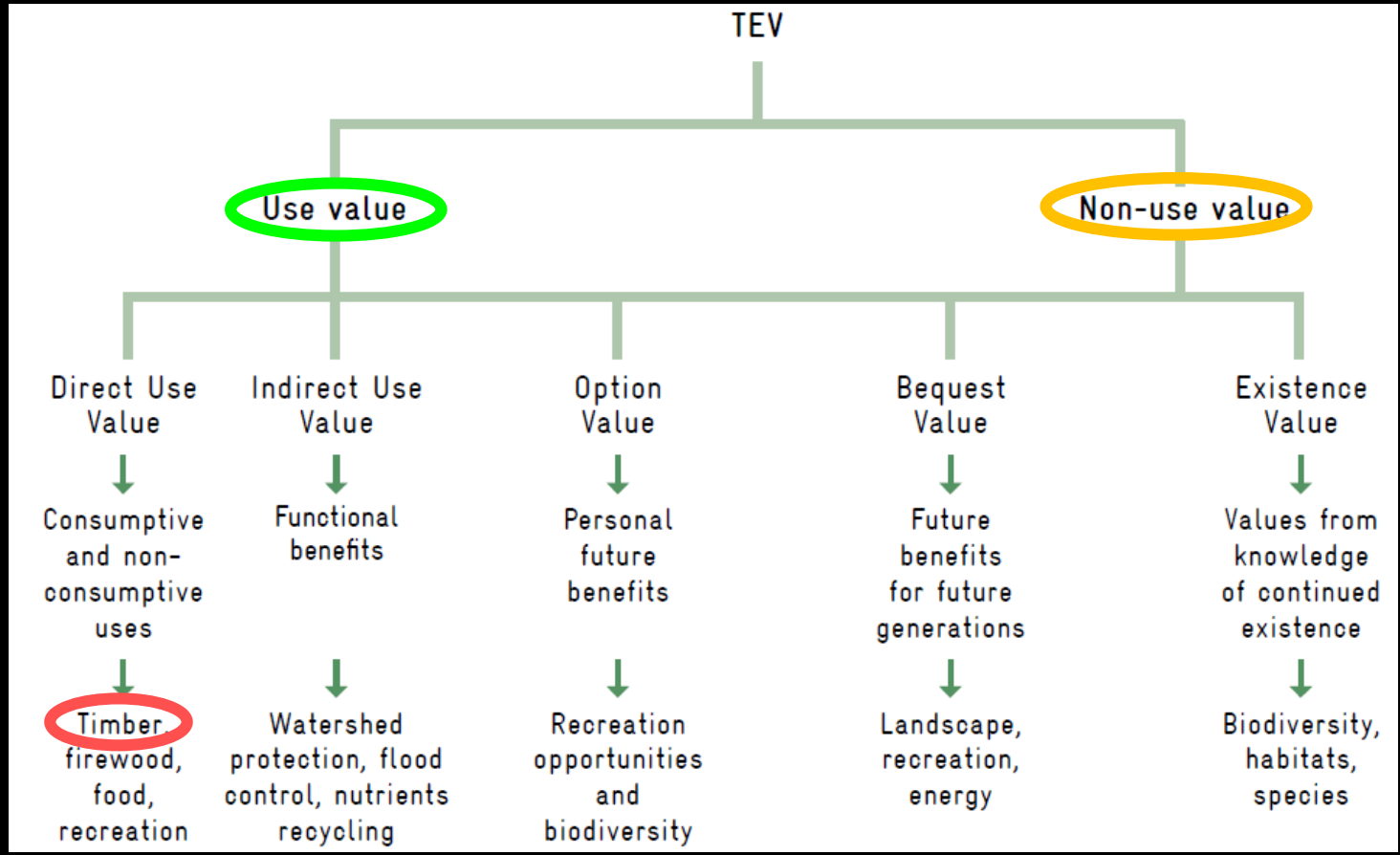
Risks associated with water reuse for forestry and agroforestry

- Domestic to industrial
- Raw to tertiary treatment - Risk of disease and environmental damage significantly reduced with treatment
- Fewer health risks compared to the irrigation of agricultural crops
- Irrigation techniques
- Practice more socially acceptable
- Site-specific recommendations required

Total economic value of forests

>90% of total forest employment informal (UNEP 2008)

Timber accounts for only 1/3 of the TEV of forests in the Med. countries



Source: modified from Pearce and Moran (1994)

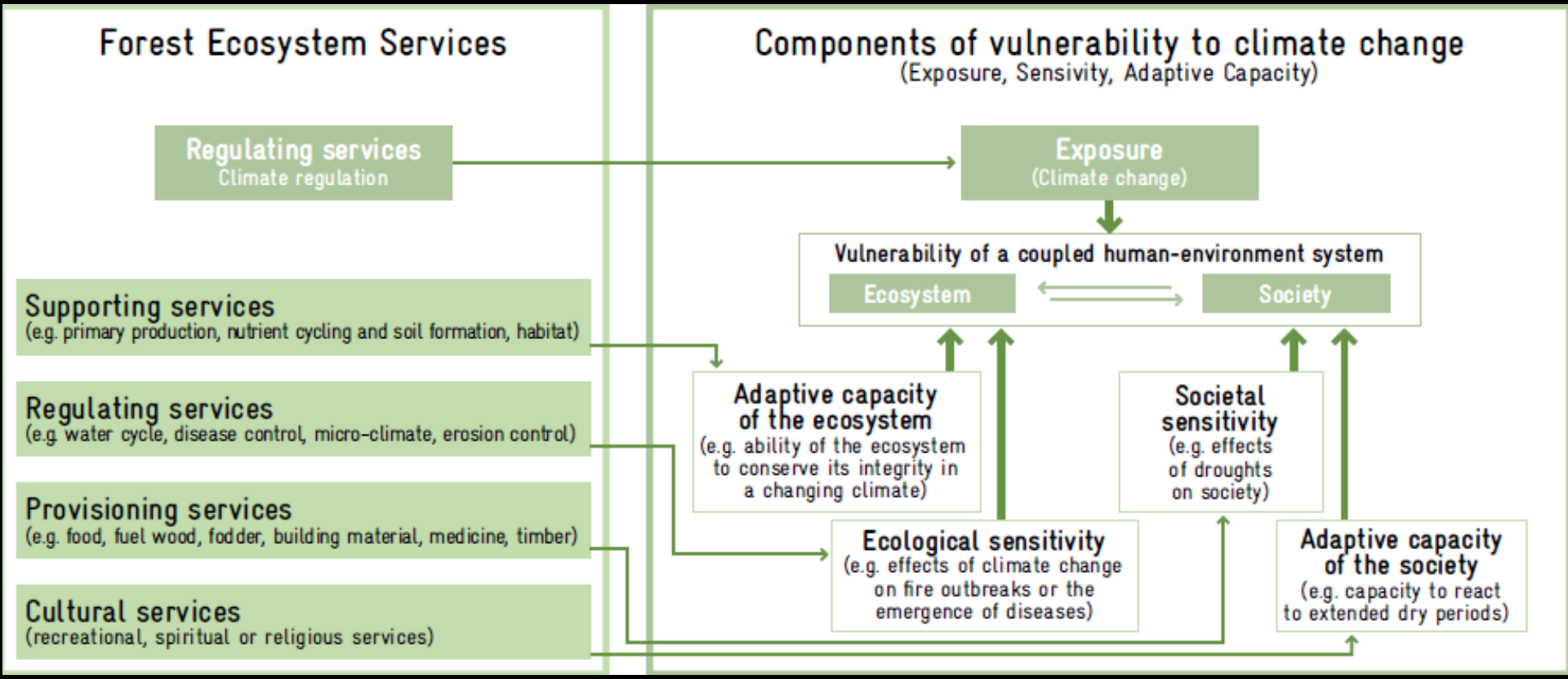
Value of forest benefits (US$, 2010 prices)

Country	WFPs[a]	Grazing and NWFPs[b]	Recreation, hunting	Watershed protection[c]	Carbon[d]	Biodiversity	TEV
Algeria	-7	47	n.c	32	-3	n.c	69
Morocco	29	44	-6	29	-3	n.c	94
Tunisia	6	73	1	26	3	9	112
Lebanon	-10	187	125	n.c	-15	8	296
Syria	4	10	n.c	101	8	n.c	123
Turkey	32	21	1	-8	11	7	63
Weighted average[e]	25	31	n.c	8	6	7	77

According to cost/benefit analyses, forests irrigated with RW cannot compete financially with agriculture as a viable land use for wood production only, except taking full consideration of the environmental and wider economic benefits

Sources: Daly-Hassen et al. (2012) for Tunisia.
Croitoru and Merlo (2005) for the other countries, updated to 2010

Relationship between forest ecosystem services and the different components of vulnerability to climate change



Source: adapted from Locatelli et al. (2008). CIFOR

Beneficiaries of forests irrigated with RW

A wide range of public and private sectors of the society:

- General public through providing cleaner and healthier environment
- Professionals by providing the design and management of environmentally-sound wastewater-irrigated timber tree plantations
- Private sector investors through creating investment opportunities
- Local citizens through providing job opportunities and training
- Local municipalities through their role in environmental management

Source: Riad, 2004

Wastewater reclamation and reuse for agroforestry in Tunisia

MUNICIPAL LANDSCAPING IN ABU DHABI

Egypt
Landscaping and trees irrigation through PPP

- Since the 1990s, Egypt decided **to reuse reclaimed water to limit desertification through planted forests** in several governorates
- **Public-private water reuse partnerships established to** sell or lease desert lands to private investors for forest plantations:
  - Large scale pilot projects for forest irrigation (70 140 ha) in East Cairo, Abu Rawash, Sadat City, Luxor, and Ismailia
  - Jatropha plantations for biofuel in Luxor (50 ha), Sohag (63 ha), and Suez (168 ha) irrigated with TWW
- In 2013 over 0.7 BCM/year of TWW were used for direct irrigation, of which 0.26 BCM undergoing secondary treatment and 0.44 BCM undergoing primary treatment

Financing opportunities for capturing forest values

Environmental conservation target	Mechanism
All forest ecosystem' goods and services	• Green accounting • Compensation mechanisms • Incentives to reforestation
Water	• PES
Biodiversity	• Eco-tourism • PES • Access and benefit-sharing
NWFPs	• Value chain development and organic certification • Ethical bio-trade
Carbon	• CDM, REDD+, LULUCF, voluntary C markets

Source: Croitoru and Liagre, 2013

Conclusion

Forests irrigated with RW can play an important role in increasing economic, social, and ecological resilience in the context of CC

- Need to support various closing loops in cities and multifunctional land-use systems combining agriculture, agroforestry, groundwater recharge, etc. in order to recover the hydrological services
- Design an integrated water reuse strategy including forest development to remediate soil erosion with supporting legal, policy, regulatory and planning framework
- Improve governance and inter-ministerial collaboration to work across scales and sectors – cities, watersheds, water, energy, agriculture, forests – and give policy directions
- Link the value chains of wastewater treatment, forest production and bioenergy production via water reuse
- Incentivize private players to invest in forests irrigated with RW through the mobilization of green investments

Thank you