WEDC Developing knowledge and capacity in water and sanitation

Options Analysis for Water Demand Management

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Loughborough University

Integrated Resource Planning Framework

- A process in which a full range of both supply-side and demand-side options are assessed against a common set of planning objectives or criteria

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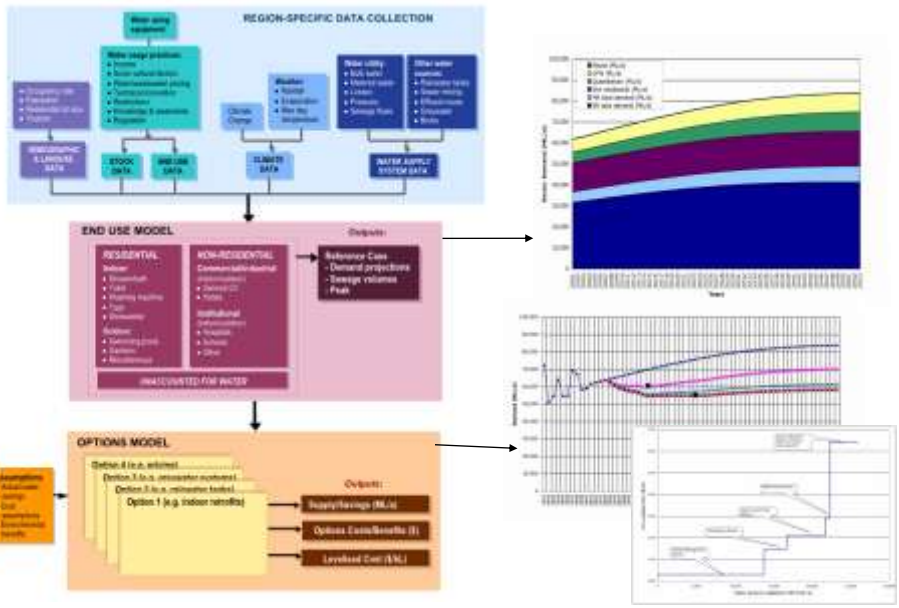
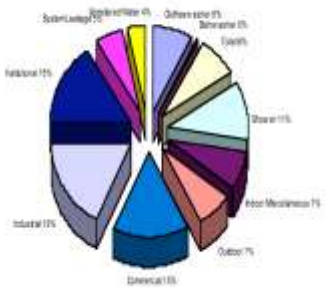
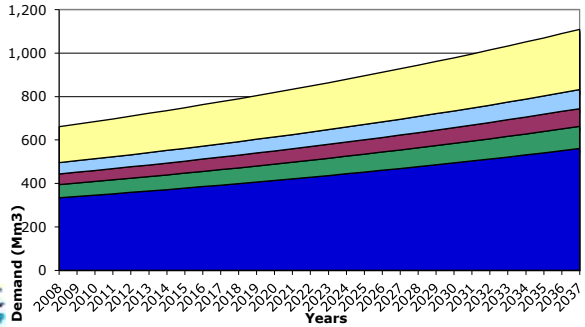
Integrated Resource Planning Framework



Key IRP Components 1

- Disaggregation of demand into end uses for accurate forecasting & targeting for potential savings





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Key IRP components 2

- Consideration of a broad spectrum of viable options that satisfy service needs
  - o Water efficiency
  - o Source substitution
  - o Re-use
  - o Supply options
- Comparison of options using a common metric, boundary and assumptions

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Key IRP components 3

- Participation of the LA – recognising that water service provision interacts with
  - o Other natural resource management systems
  - o Other urban development systems
  - o Consumer preferences
- Adaptive management
  - o On-going learning process
  - o Initiatives decided upon, implemented and evaluated in repeated cycles

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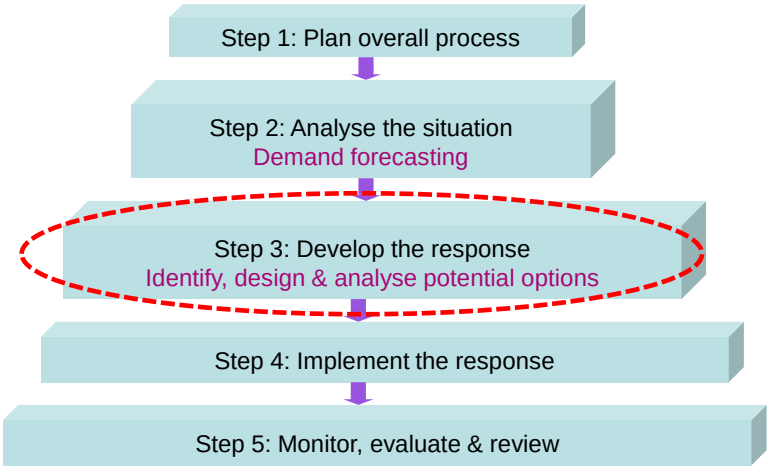
The 5-step IRP Framework



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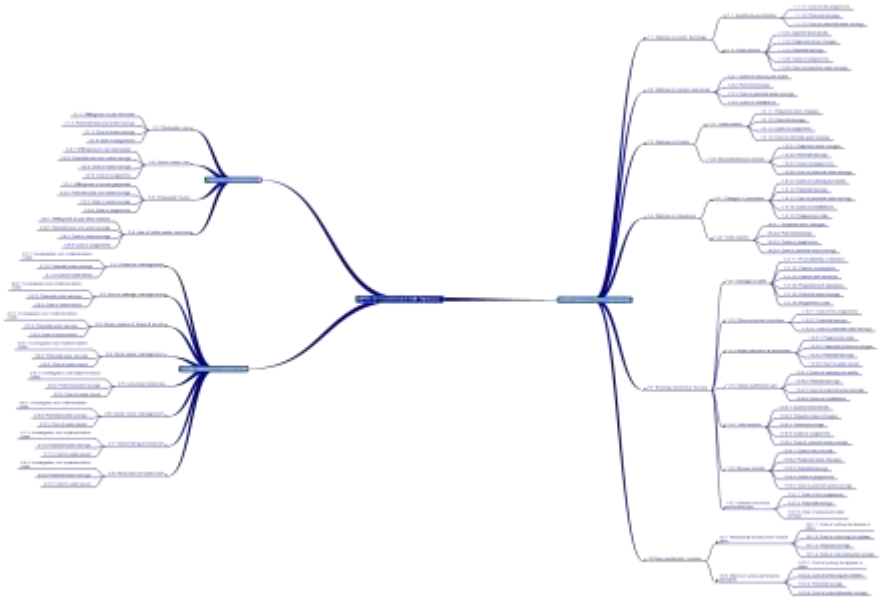
Mind map of a DM options model



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Model design

- Time frame is 30 years, 2010-2040
- 12 water demand management options modelled
- Designed for fictive city, but with realistic assumptions based on Accra & Alexandria
- Model layout still to be made more illustrative
- Non-revenue yet to be specified by:
  - Physical losses
  - Reduction in water theft (illegal connections)
  - Improved metering coverage
  - Improved billing procedures
  - Good practices of installation, maintenance & replacement of meters

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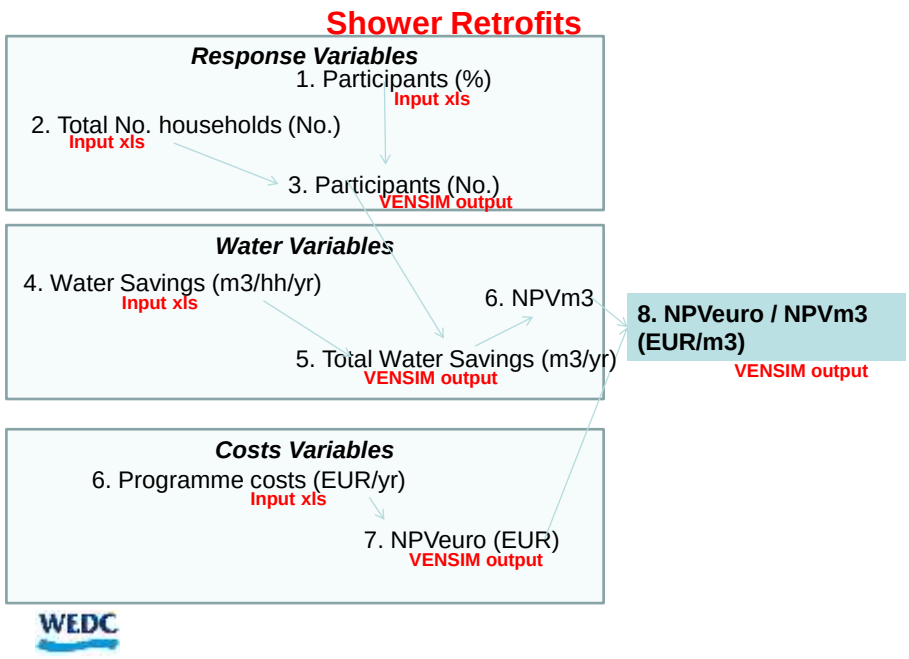
VENSIM WDM options model structure



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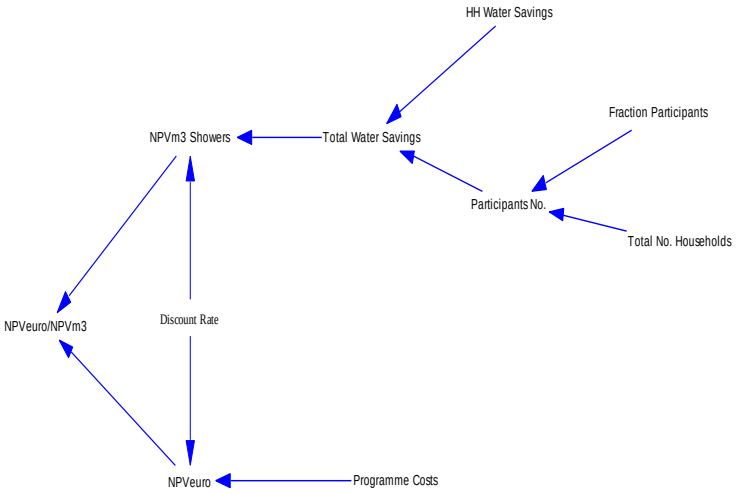
VENSIM layout / shower retrofits



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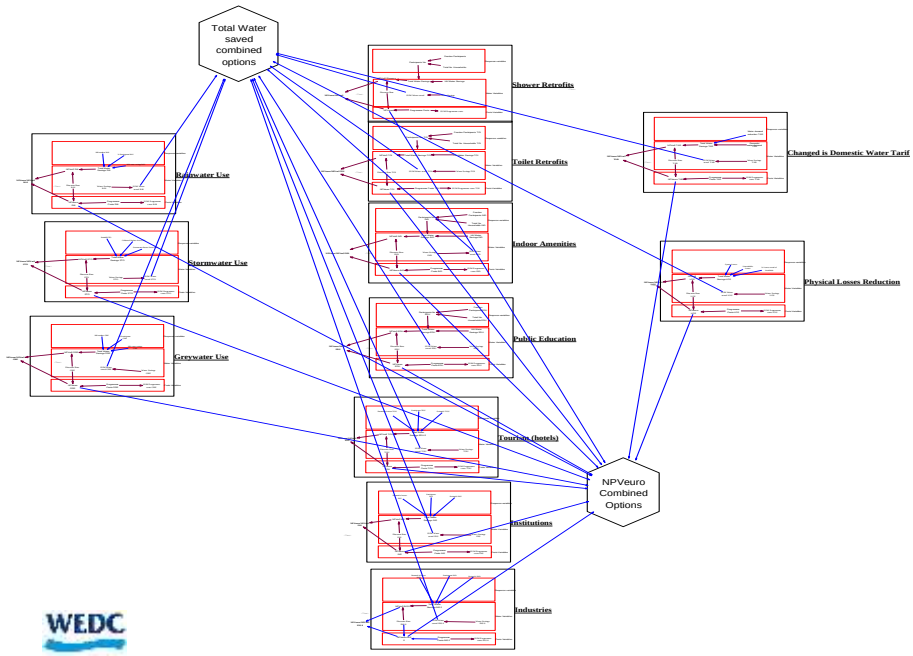
VENSIM model layout (draft)



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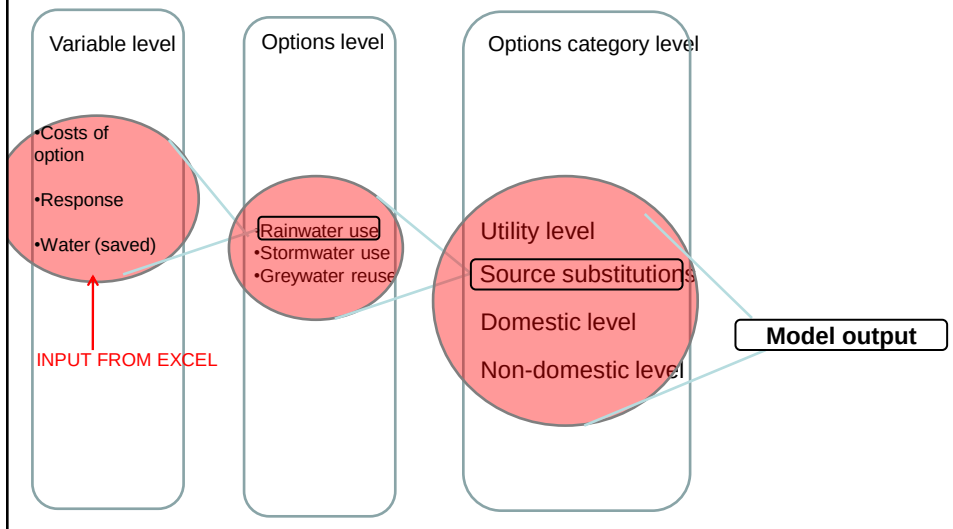
Structure of the VENSIM model



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Results

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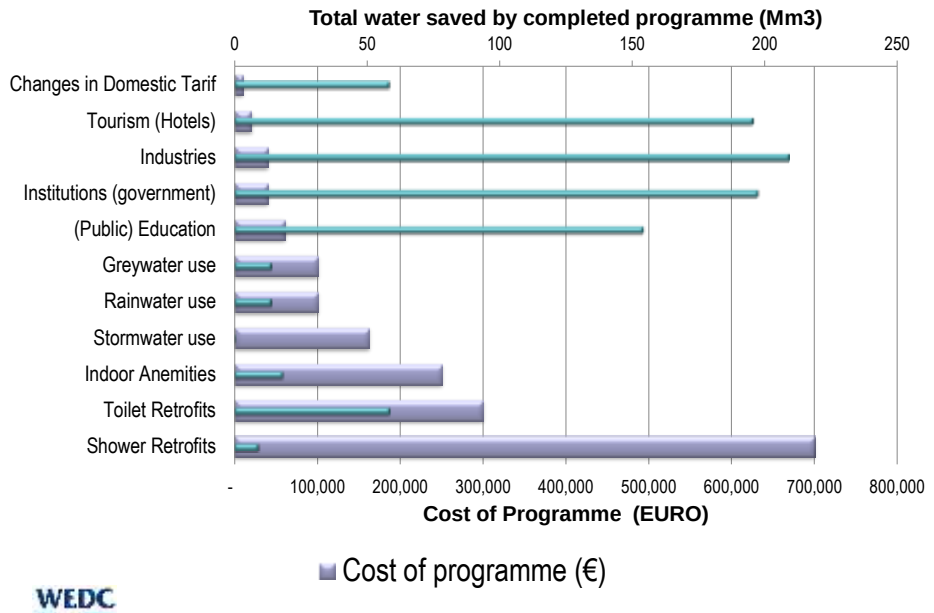
Programme costs vs. water savings



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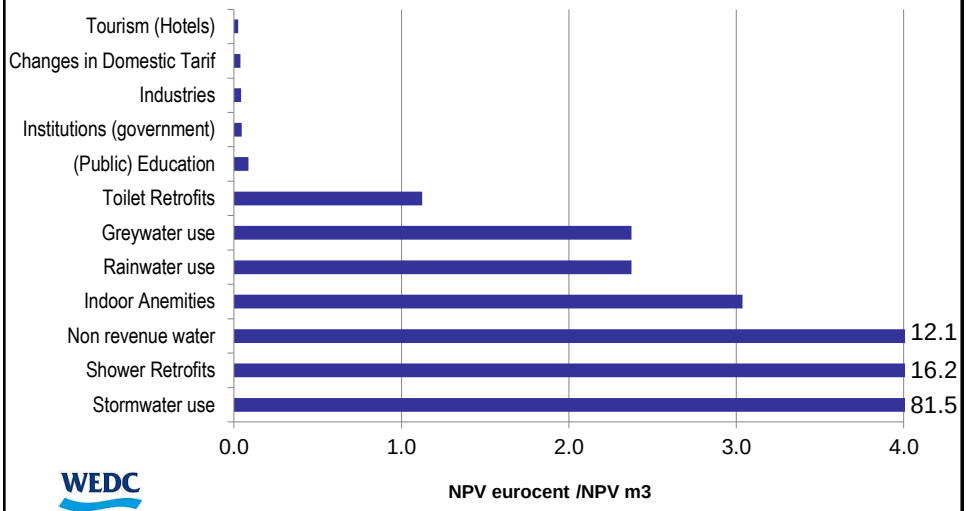
Costs effectiveness of programmes



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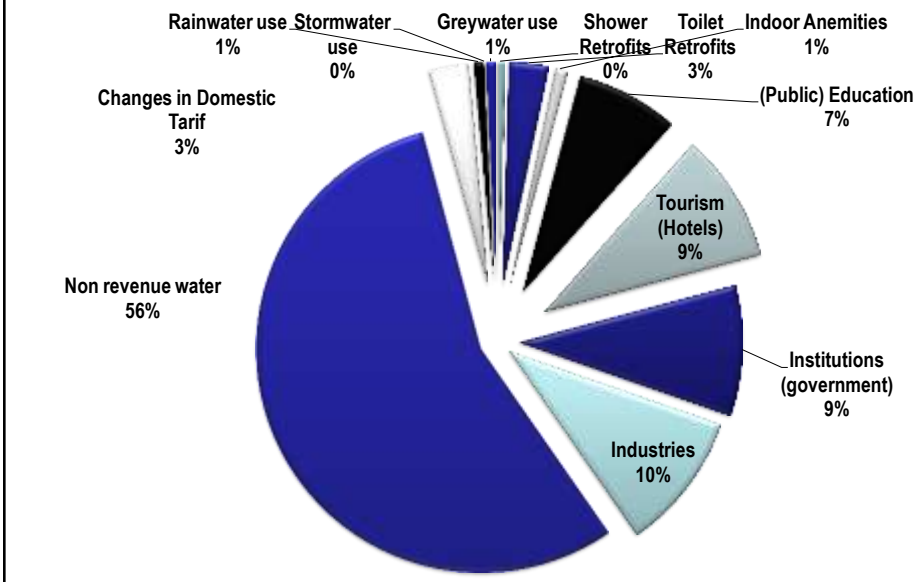
Share of WDM option in total potential water volume saved



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Spreadsheet layouts

Times series and constant value-input spreadsheet for VENSIM

WDM Options	*discount rate:*	7%	Time step	0	1	2	3	4	5	6
USER INPUT	VENSIM INPUT	CALCULATED	YEAR	2010	2011	2012	2013	2014	2015	2016
general data	households	800,000								
END USE LEVEL										
Shower Retrofits										
Participants	%	25%	1	1%	5%	10%	15%	20%	25%	25%
Water savings	litres/hh/d	5	2							
	m3/hh/year	1.8	3							
	m3/year	365,000	4	14,600	73,000	146,000	219,000	292,000	365,000	365,000
	total (m3)	10,234,600	5							
	NPVm3	3,649,392	6							
Costs	total in EUR	700,000	7	200,000	200,000	100,000	100,000	100,000	0	0
	NPV EUR	590,822	8							
Unit cost	NPV EUR/NPVm3	0.162	9							
Toilet retrofits										
Participants	%	20%	1	1%	4%	8%	12%	16%	20%	20%
Water savings	litres/hh/d	40	2							
	m3/hh/year	15	3							
	m3/year	2,336,000	4	93,440	467,200	934,400	1,401,600	1,868,800	2,336,000	2,336,000
	total (m3)	65,501,440	5							
	PVm3	23,356,106	6							
Costs total	EUR	300,000	7	100,000	100,000	100,000	0	0	0	0
	NPV EUR	262,432	8							
Unit cost	NPV EUR/NPVm3	0.0112	9							
Indoor Anemities										
Participants	%	10%	1	0%	2%	4%	6%	8%	10%	10%
Water savings	litres/hh/d	25	2							

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Spreadsheet layouts

Summary of water savings

Water Savings m3/year	0 2010	1 2011	2 2012	3 2013
End Use Level				
Shower Retrofits	14,600	73,000	146,000	219,000
Toilet retrofits	93,440	467,200	934,400	1,401,600
Indoor Anemities	29,200	146,000	292,000	438,000
(Public) Education	186,880	951,219	1,936,682	2,957,314
Tourism (Hotels)	121,400	1,235,852	1,572,622	2,134,572
Institutions (government)	122,500	1,247,050	1,586,871	2,153,913
Industries	129,917	1,322,552	1,682,947	2,284,320
sub total	**697,937**	**5,442,873**	**8,151,522**	**11,588,719**
Source level				
Rainwater use	8,760	89,177	113,477	154,027
Stormwater use	400	4,000	5,000	6,667
Greywater use	8,760	89,177	113,477	154,027
sub total	**17,920**	**182,354**	**231,955**	**314,720**
Utility Level				
Changes in Domestic Tarif	0	1,701,078	1,731,697	1,762,868
Non revenue water	41,322,222	41,322,222	41,322,222	41,322,222
sub total	41,322,222	43,023,300	43,053,920	43,085,090

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Advantages of VENSIM (over a spreadsheet based model)

- Visualization of relationships between parameters & variables
- With each time step parameters can change; you can play with them..
  - You can explore and better understand interaction between system components
- Sensitivity analysis – easy to do.
- Automatic generation of parameters (with units) and equations used
- Error messages when units are not compatible, when values become unrealistic during modeling, etc.
- Can be used to carry out object-oriented modeling

VENSIM facilitates getting a deeper understanding of the effect of any system and its dynamic

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Further information

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Thank you for your attention

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