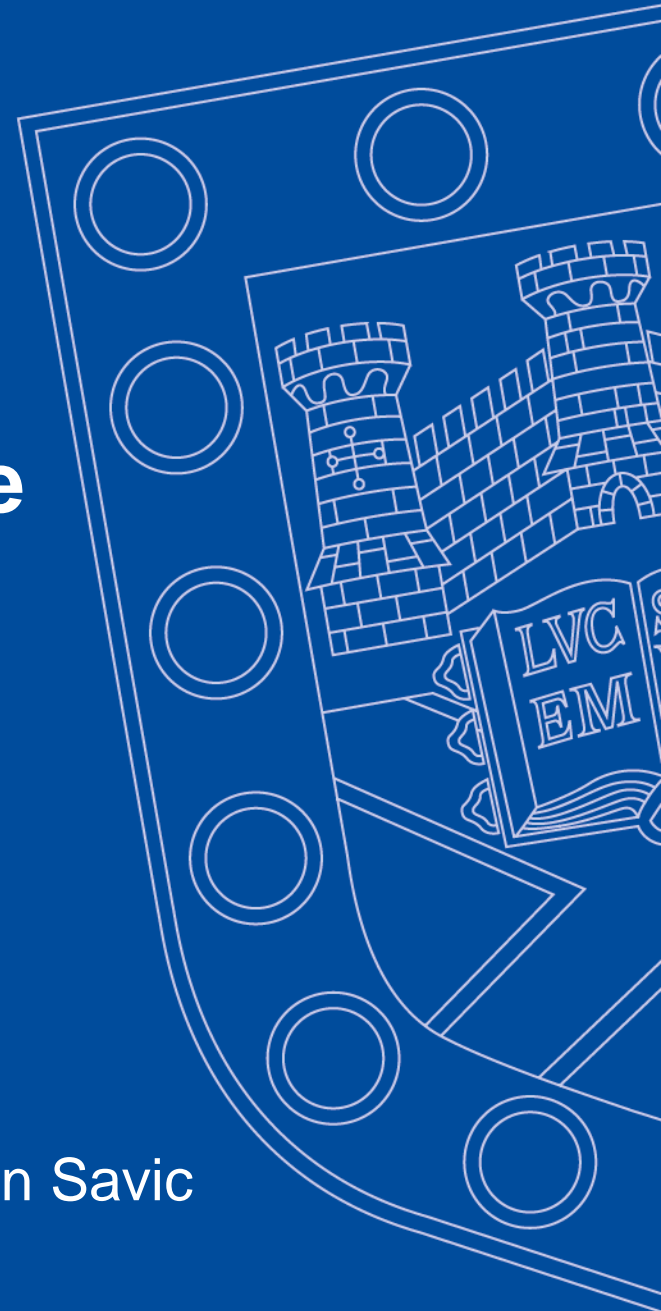


Assessing and Modelling the Influence of Household Characteristics on Per Capita Water Consumption

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Presentation outline

- Aim
- Case study (Duhok)
- Methodology for data collection (survey)
- Results
- Conclusions and key findings



Aim

To investigate and model water consumption trends in Duhok, Iraq.



Case study: Duhok city

- ❖ Population: **295,000 inhabitants**⁽²⁾
- ❖ Area: **577 km²**⁽²⁾
- ❖ Annual rainfall: **550 mm/year**⁽³⁾
- ❖ Ave. temperature: **2°C in winter**
43°C in summer⁽³⁾
- ❖ Water sources
 - Earth dam: **(47.5 Million m³)**⁽⁴⁾
 - National water supply network:
(66.1 Million m³/year)⁽⁴⁾
 - Wells: **(8.3 Million m³/year)**⁽⁴⁾



Duhok city location in Kurdistan, Iraq⁽¹⁾

¹Kurdistan ministry of planning, 2014

²Kurdistan regional statistics office, 2014

³Duhok directorate of seismology and meteorology, 2015

⁴Duhok directorate of water and sewerage, 2014

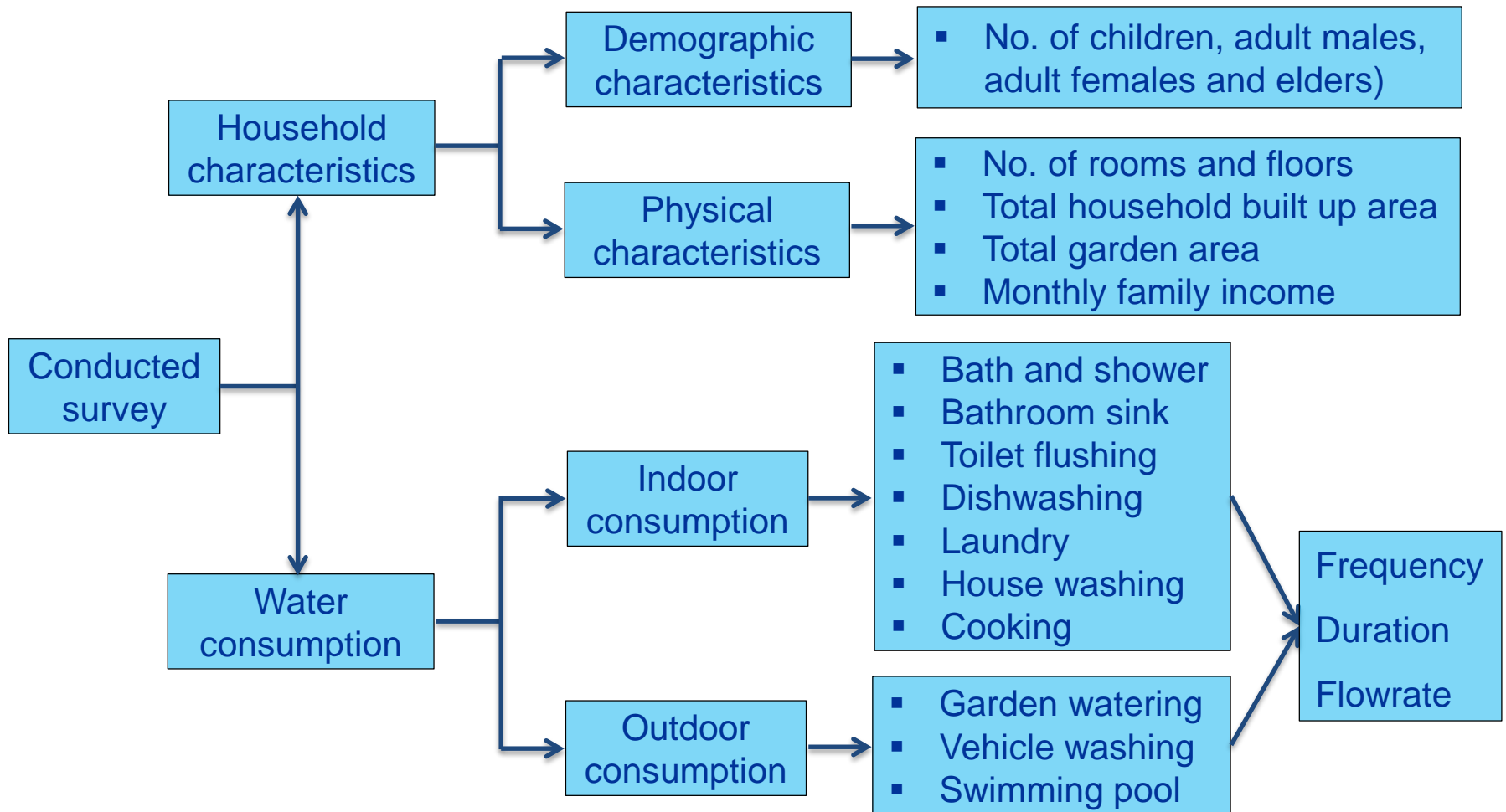


Methodology for data collection

- MCQ type
- No. of questions: over 40
- Distributed: 419 households
- Received: 407 households



Household survey



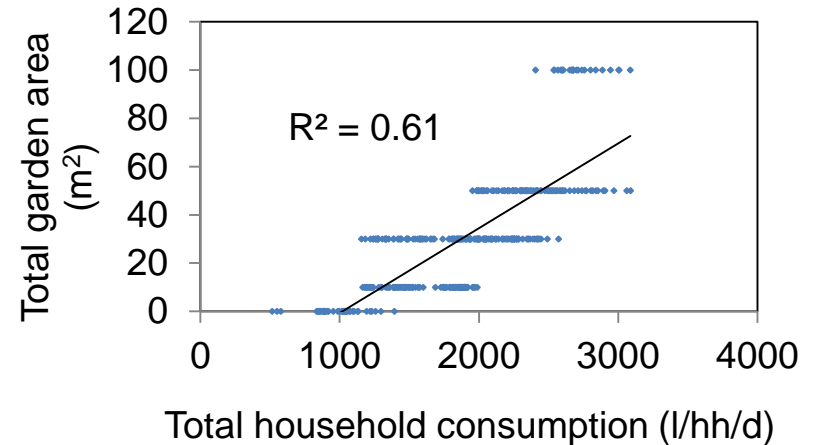
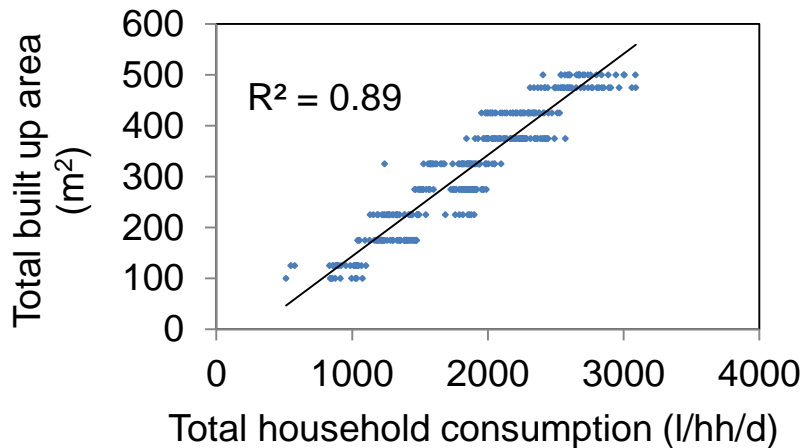
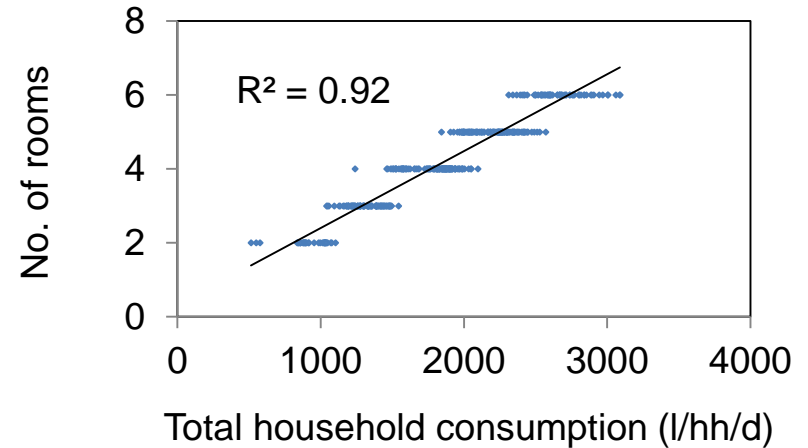
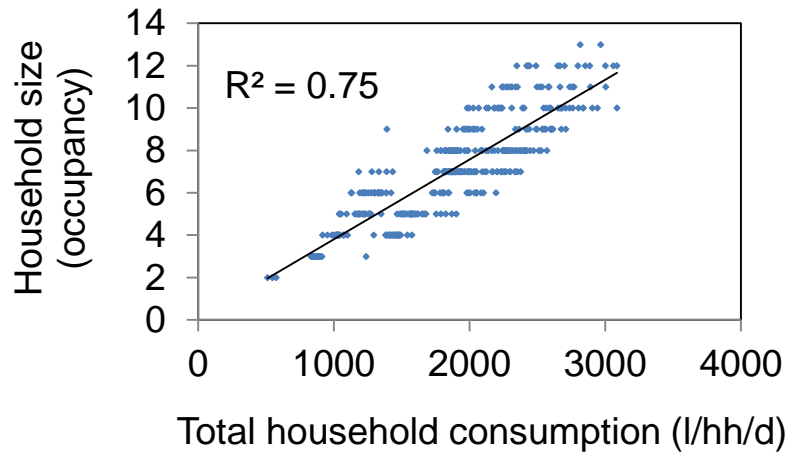
Results

Household characteristics	Unit	Mean	
		Current survey	CSO and KRSO survey
Household size (occupancy)	No./household	7.04	6.7
Number of children (<15 years)	No./household	2.22	2.47
Number of adult males members (15-65 years)	No./household	2.27	1.96
Number of adult females members (15-65 years)	No./household	2.33	2.01
Number of elders (>65 years)	No./household	0.22	0.25
Household type	%	Houses (91.9%) Apartments (8.9%)	Houses (95.8%) Apartments (4.2%)
Total built up area of all floors	m ² /household	314.6	283.1
Garden area per household	m ² /household	29.6	
Number of rooms in the household	No.	4.19	
Number of floors in the household	No.	1.48	
Monthly family income/household	10 ³ ID/month	1857.6	1664.9

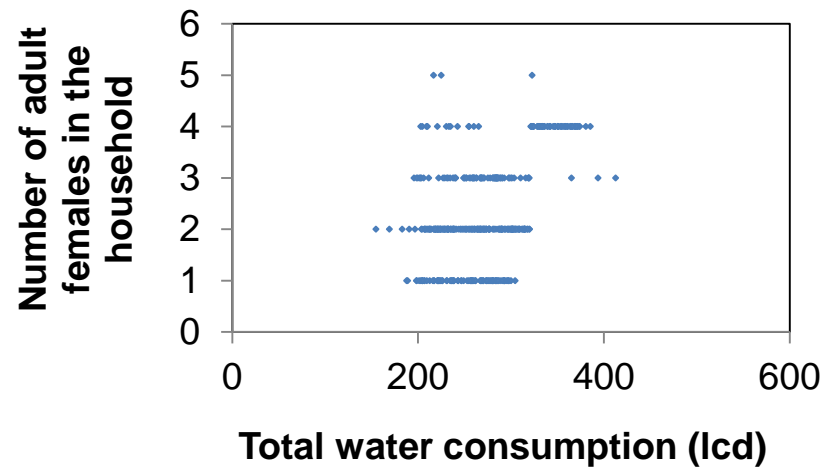
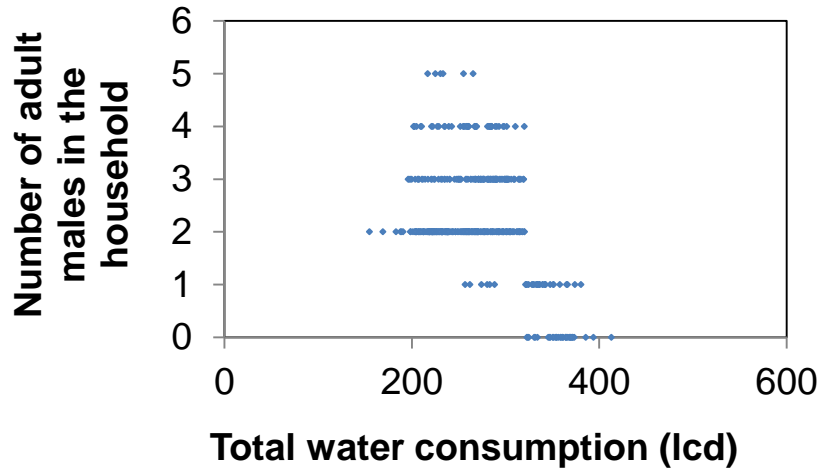
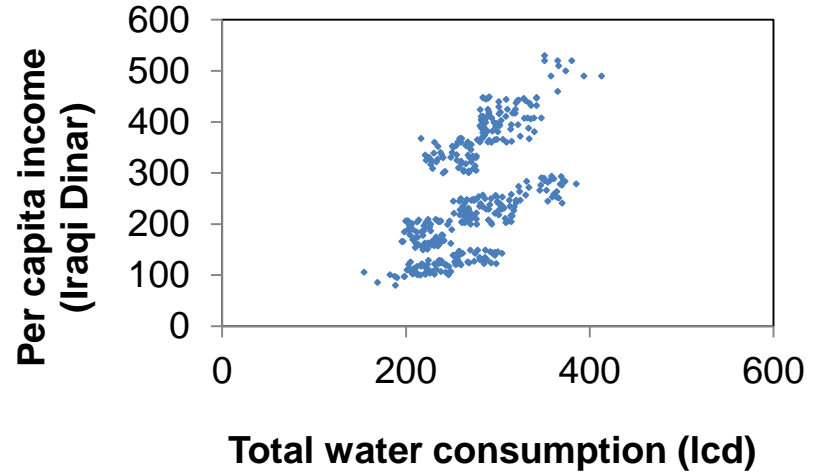
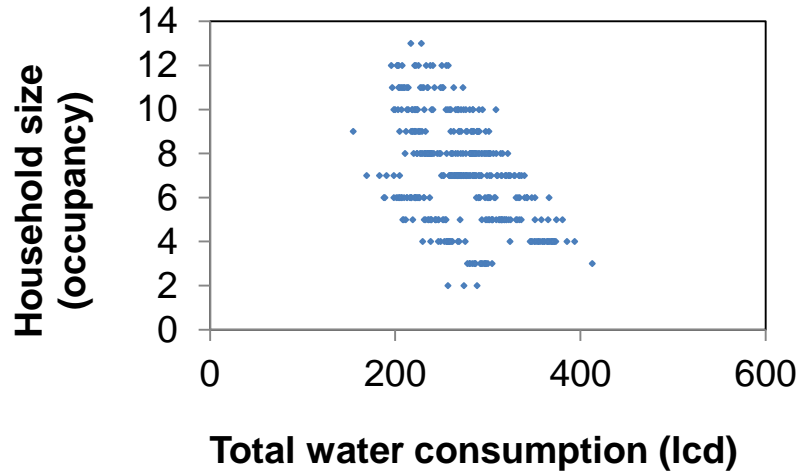
* ID=Iraqi Dinnar



Household characteristics & total average consumption



Household characteristics & per capita consumption



Per capita income & per capita water consumption

Income group	Income range in Iraqi Dinar (ID) ⁽¹⁾		Number of households	Per capita water consumption (lpd)
	Per household	Per capita		
Low	<1 Million	<150 Thousand	92	241
Medium	1 – 2 Million	150 – 300 Thousand	176	272
High	>2 Million	>300 Thousand	139	290

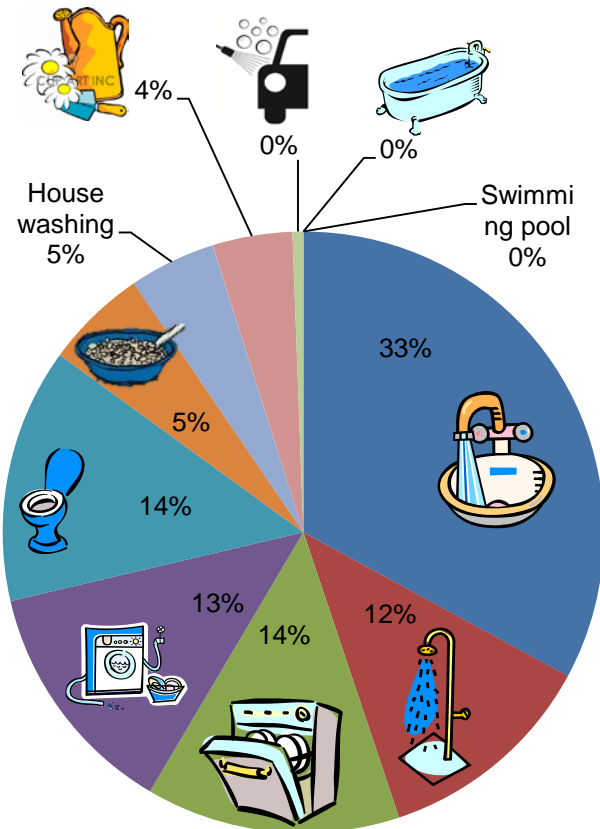
Income group thresholds were decided using the classification given in CSO and KRSO survey in Iraq (2012)

¹Central Statistical Organisation (CSO) and Kurdistan Regional Statistics Office (KRSO), 2012. Iraqi household socio-economic survey report.

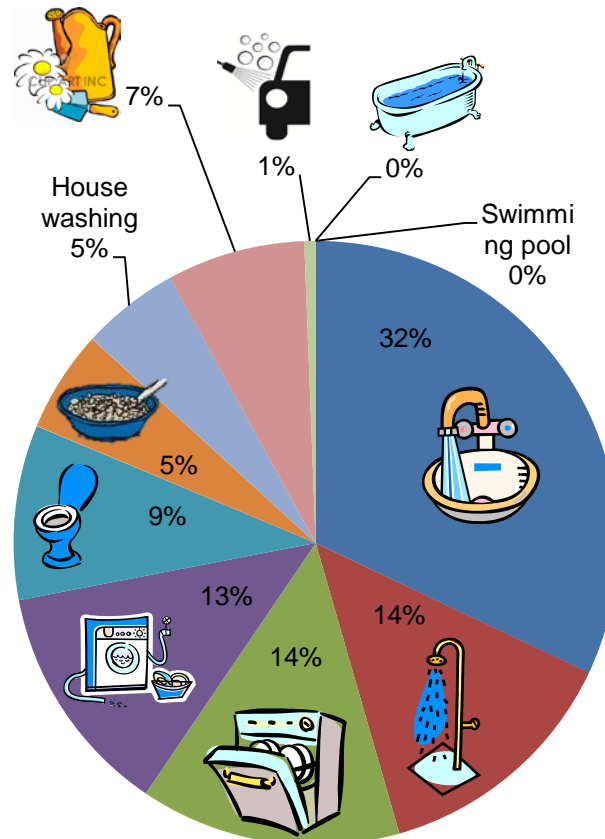


Proportions of water end-uses in all income groups

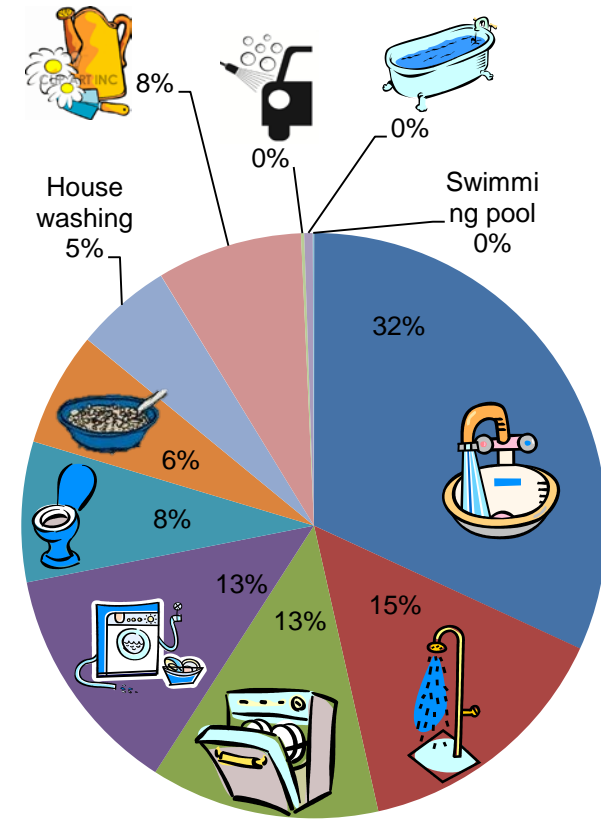
Low income



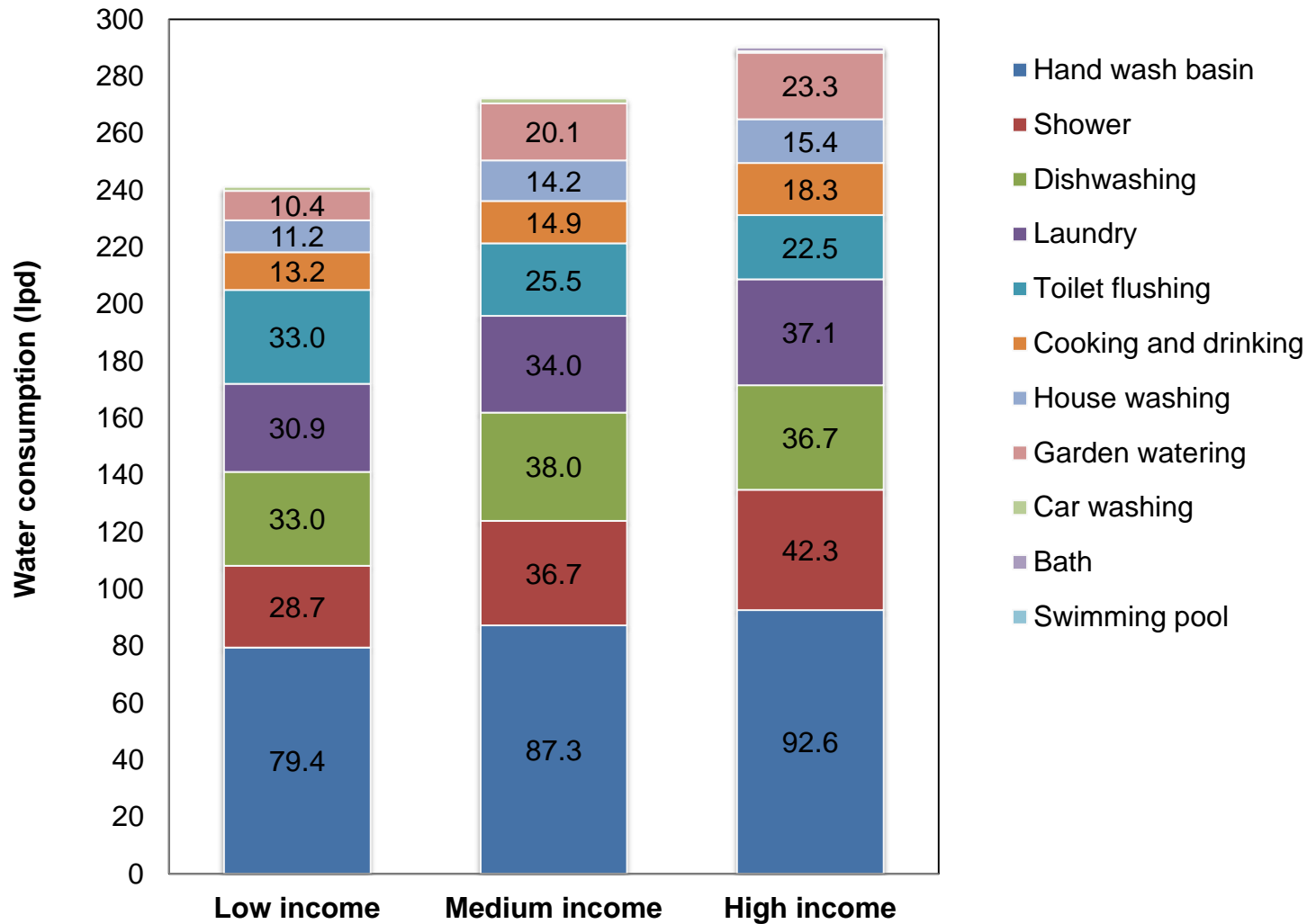
Medium income



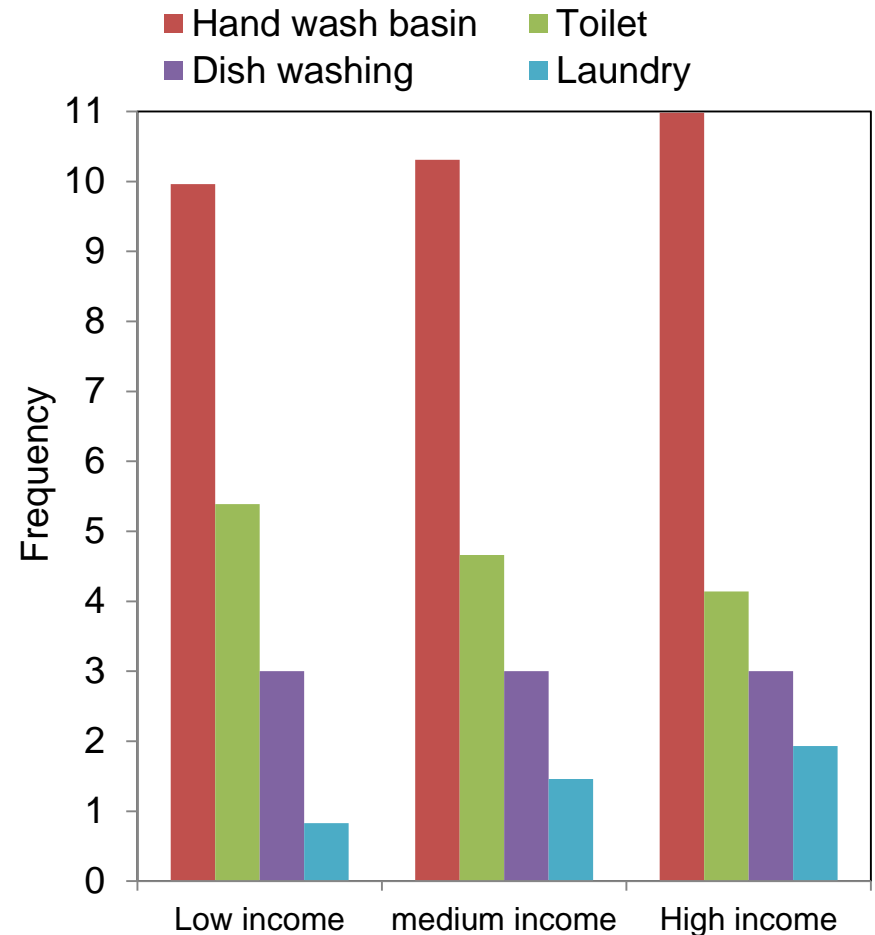
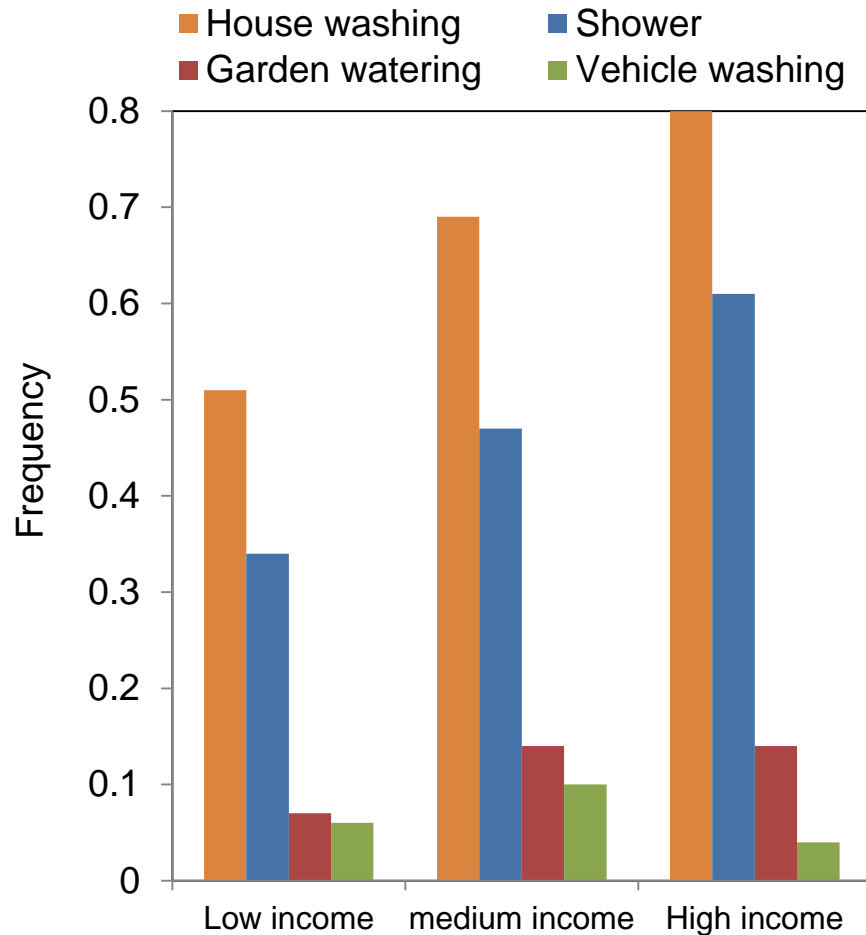
High income



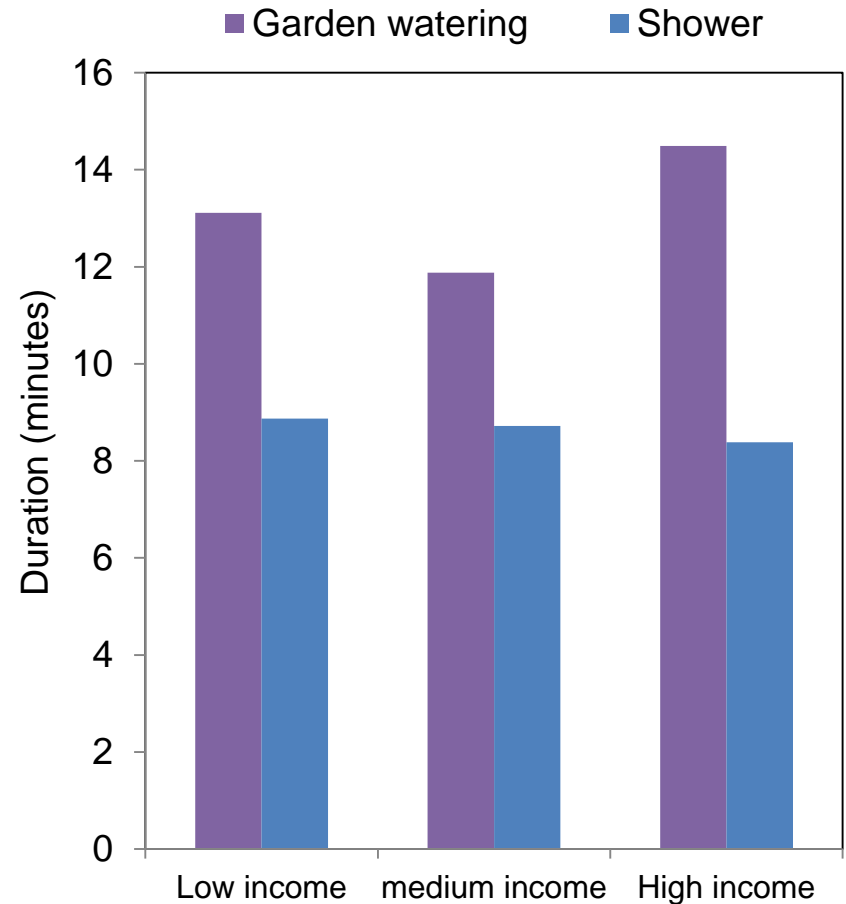
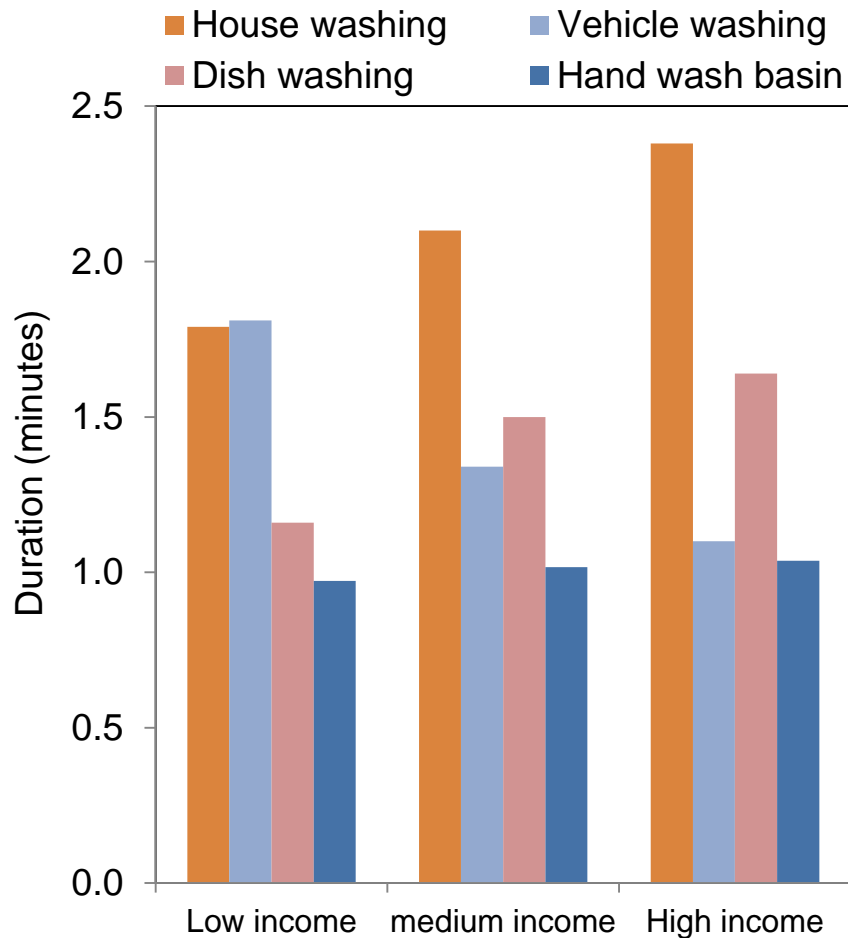
Impact of per capita monthly income on water end-uses



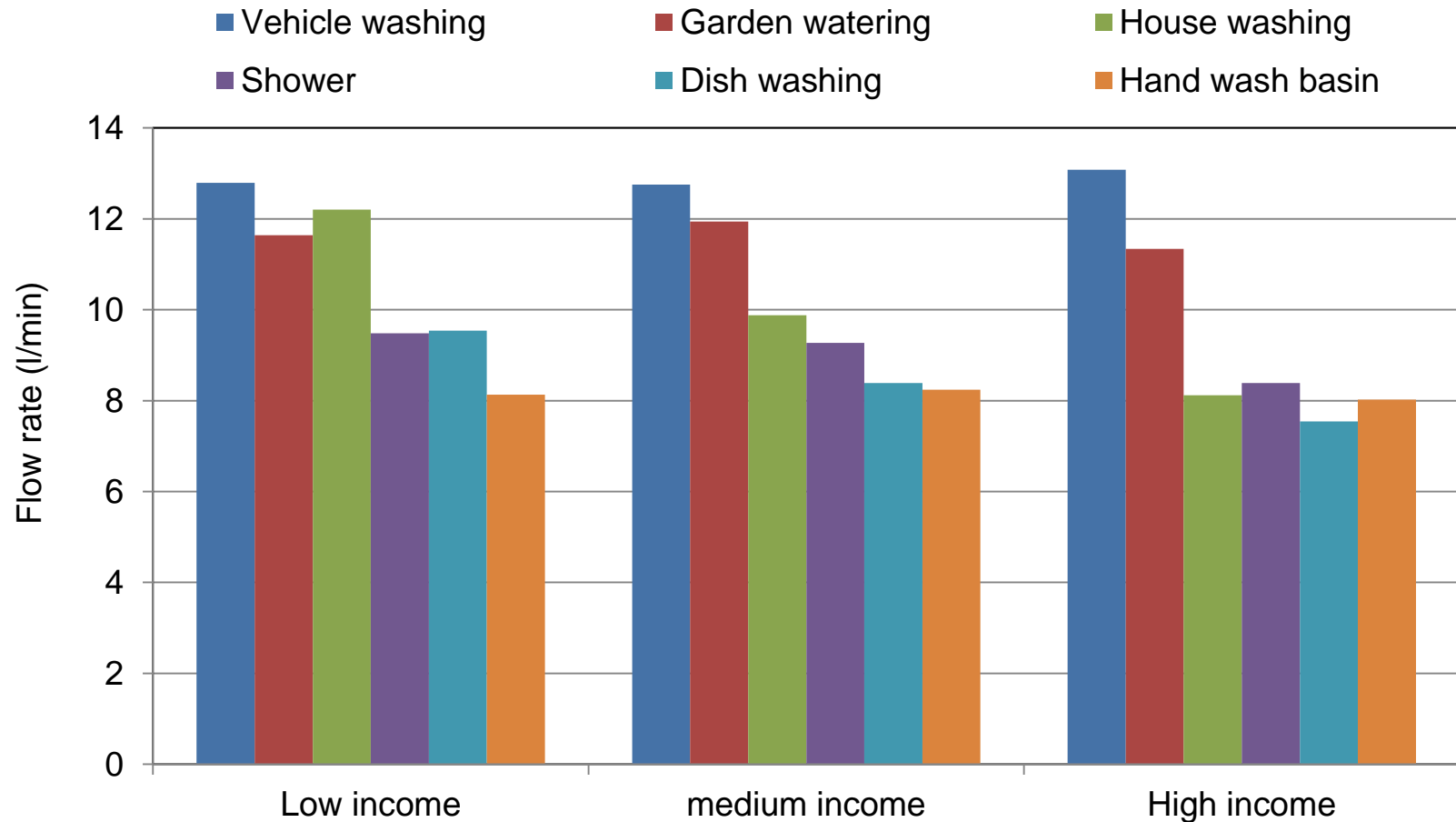
Impact of per capita monthly income on the frequency of water end-uses



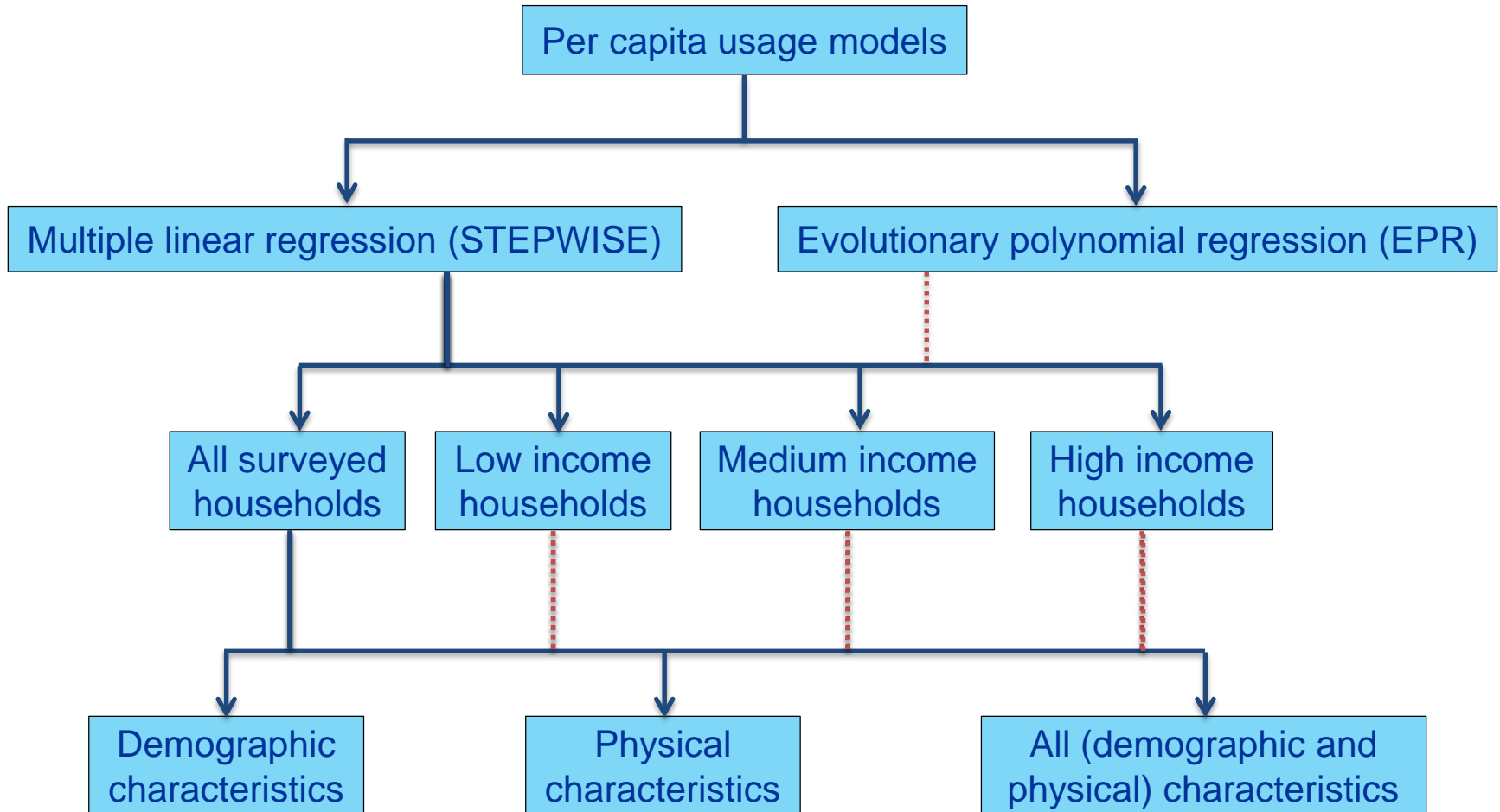
Impact of per capita monthly income on the duration of water end-uses



Impact of per capita monthly income on the flowrate of water end-uses



Modelling daily per capita usage with household characteristics

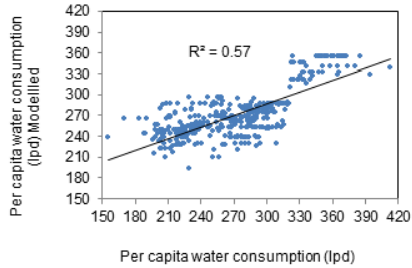


Comparison between STEPWISE and EPR regression models

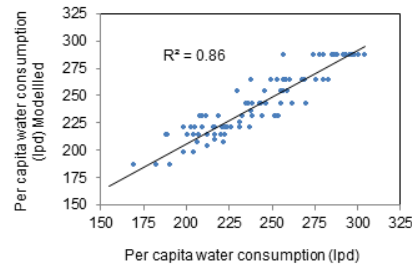
Relationship of per capita water consumption with	Coefficient of determination (R^2)					
	Demographic characteristics		Physical characteristics		Demographic and Physical characteristics	
	EPR	STEPWISE	EPR	STEPWISE	EPR	STEPWISE
All surveyed households	0.63	0.57	0.84	0.74	0.90	0.87
Low income households	0.87	0.86	0.80	0.76	0.92	0.92
Medium income households	0.95	0.92	0.88	0.86	0.95	0.95
High income households	0.88	0.87	0.77	0.75	0.89	0.91



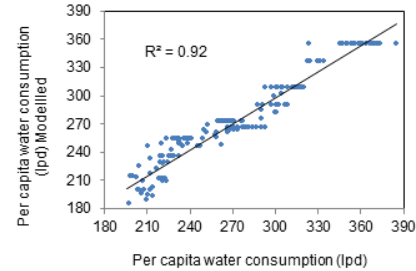
STEPWISE based models



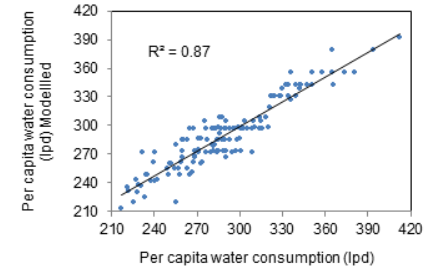
a. All surveyed households
(Demographic characteristics)



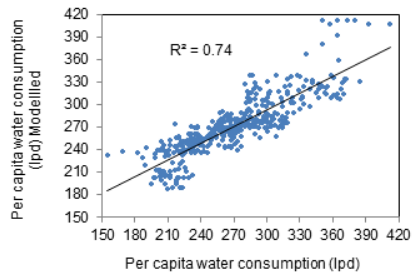
d. Low income households
(Demographic characteristics)



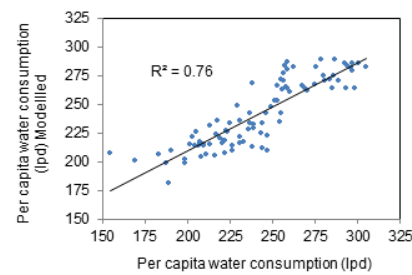
g. Medium income households
(Demographic characteristics)



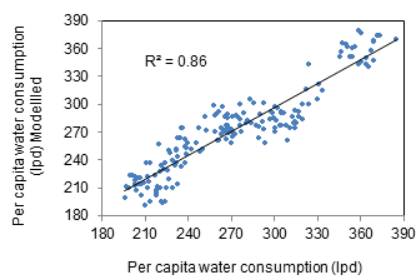
j. High income households
(Demographic characteristics)



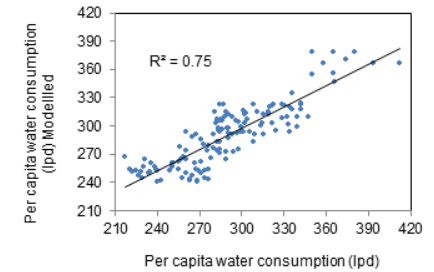
b. All surveyed households
(Physical characteristics)



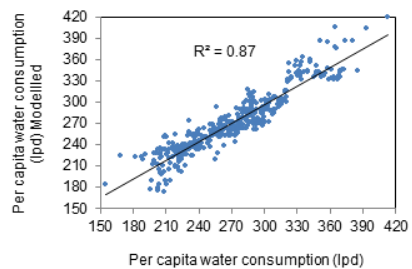
e. Low income households
(Physical characteristics)



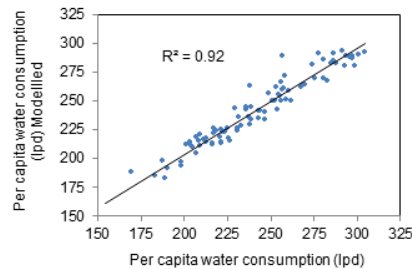
h. Medium income households
(Physical characteristics)



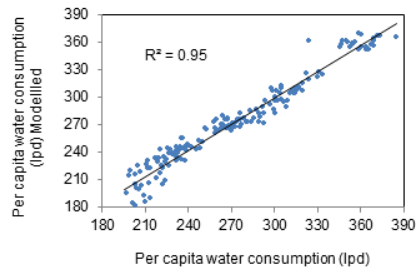
k. High income households
(Physical characteristics)



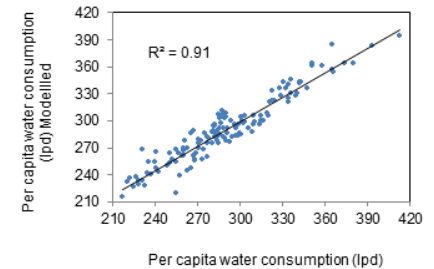
c. All surveyed households
(Physical & demographic characteristics)



f. Low income households
(Physical & demographic characteristics)



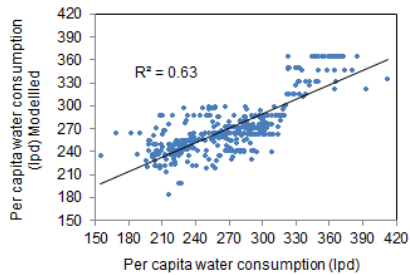
i. Medium income households
(Physical & demographic characteristics)



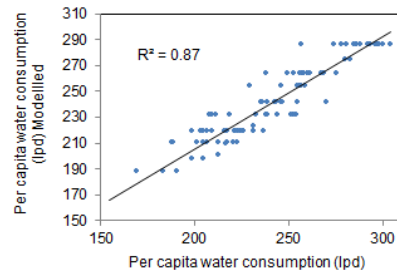
l. High income households
(Physical & demographic characteristics)



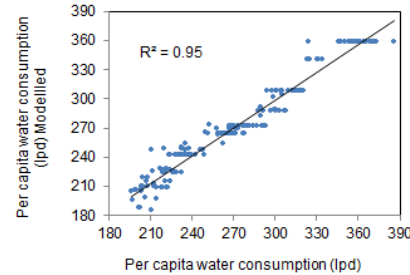
EPR based models



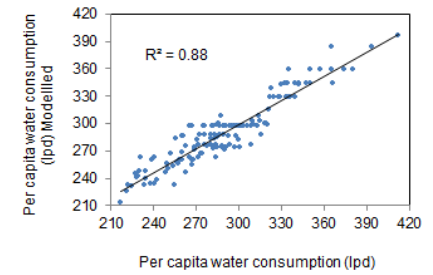
a. All surveyed households
(Demographic characteristics)



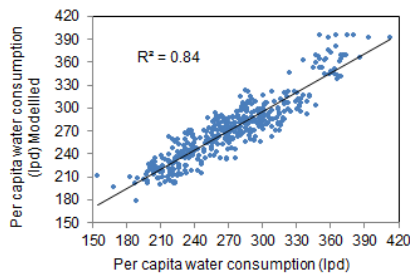
d. Low income households
(Demographic characteristics)



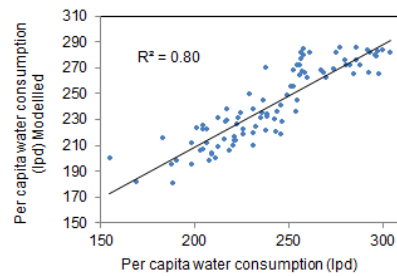
g. Medium income households
(Demographic characteristics)



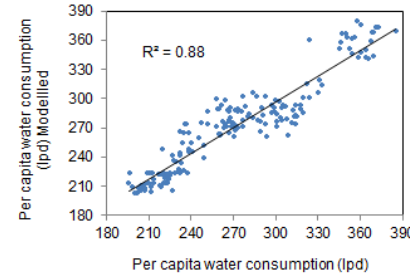
j. High income households
(Demographic characteristics)



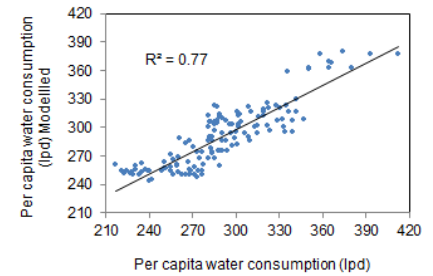
b. All surveyed households
(Physical characteristics)



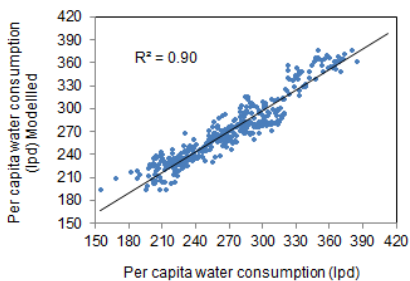
e. Low income households
(Physical characteristics)



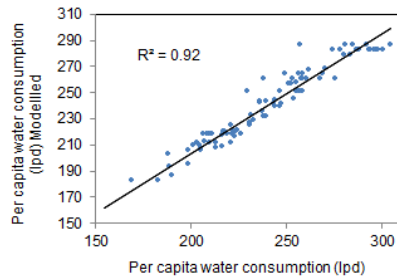
h. Medium income households
(Physical characteristics)



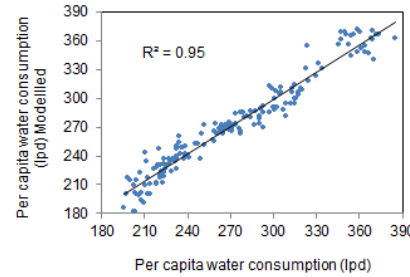
k. High income households
(Physical characteristics)



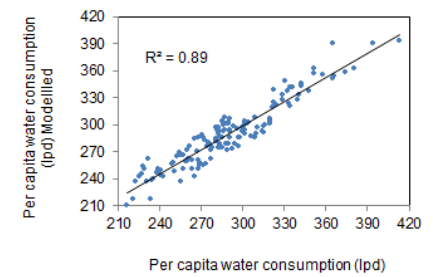
c. All surveyed households
(Physical & demographic characteristics)



f. Low income households
(Physical & demographic characteristics)



i. Medium income households
(Physical & demographic characteristics)



l. High income households
(Physical & demographic characteristics)



Conclusions and key findings

- The **pcc** increases with the increase in household income and decreases with the increase in the household occupancy.
- **Frequency** of all water end-uses increases with the increase in per capita income except for toilet usage.
- **Toilet use frequency** in low income households is higher than that in medium and high income groups.
- The **duration of hand wash basin tap** in Duhok is much higher than typical values in the developed world. This indicates an additional water use activities (e.g. ablution) via the hand wash basin tap.



- **Flow rate** from different water end-uses decreases with increase in the per capita income, suggesting that households in high income group are relatively new and fitted with water efficient appliances.
- **Pcc** decreases with the increase in **male adults**, elders and children but increases with the increase in number of **adult females** in a household.
- Using the survey data, it is possible to **predict pcc**. The quality of prediction improves when the full data was disaggregated into low, medium and high income group households.
- The **models** based on **EPR** offer a marginal improvement in the predictions quality.



Any questions?

