Με τη συγχρηματοδότηση της Ελλάδας και της Ευρωπαϊκής Ένωσης

WATER POLICIES – SD ANALYSIS

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The success of a water saving campaign (assuming no spatial expansion) depends on the penetration rate of WDM technologies, which is driven by socio-economic factors and dynamics.

For this reason, a system dynamics (SD) model is coupled with an urban water cycle model (UWOT). Two water-saving technological configurations are investigated.

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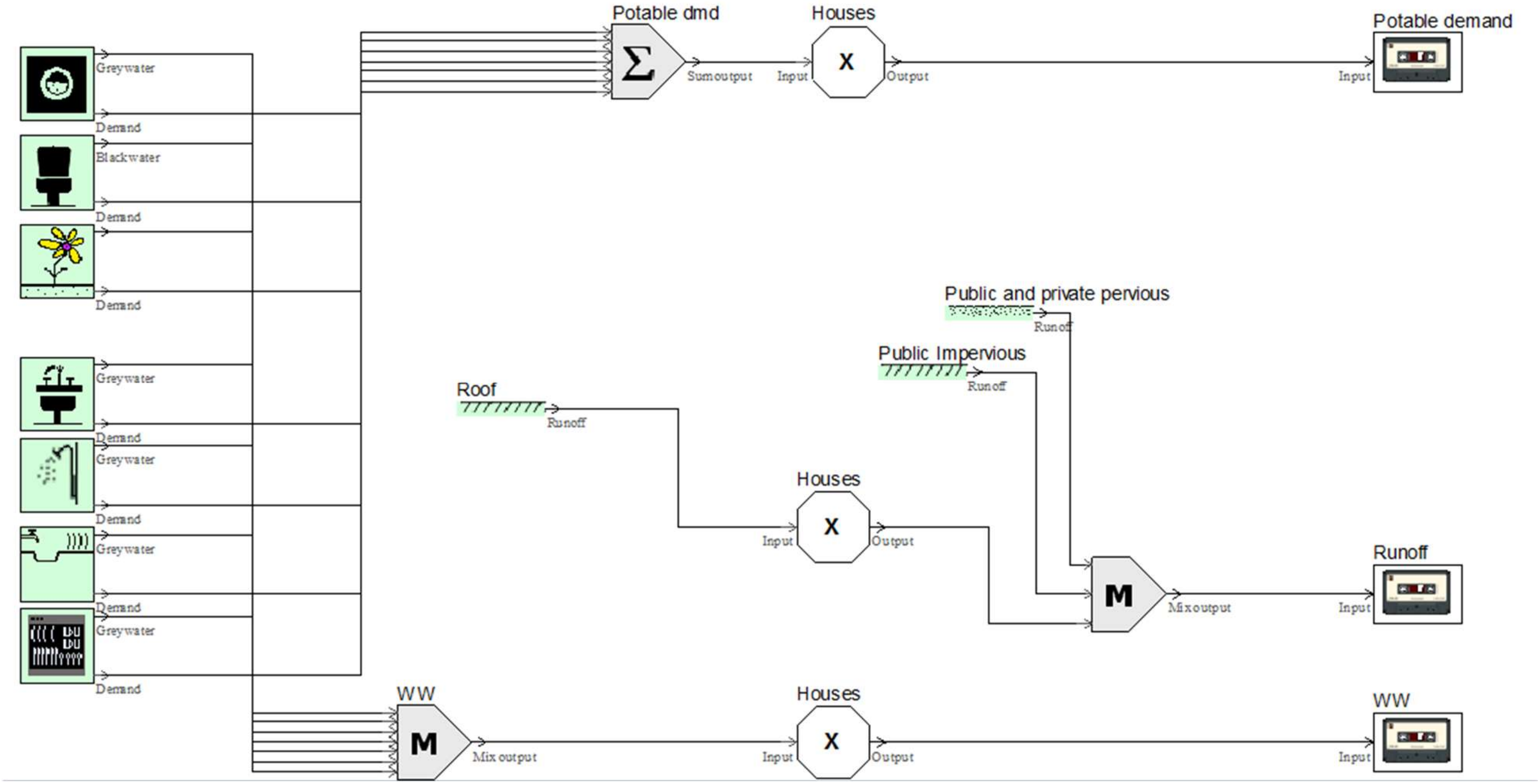
Configuration 1 – low consumption appliances



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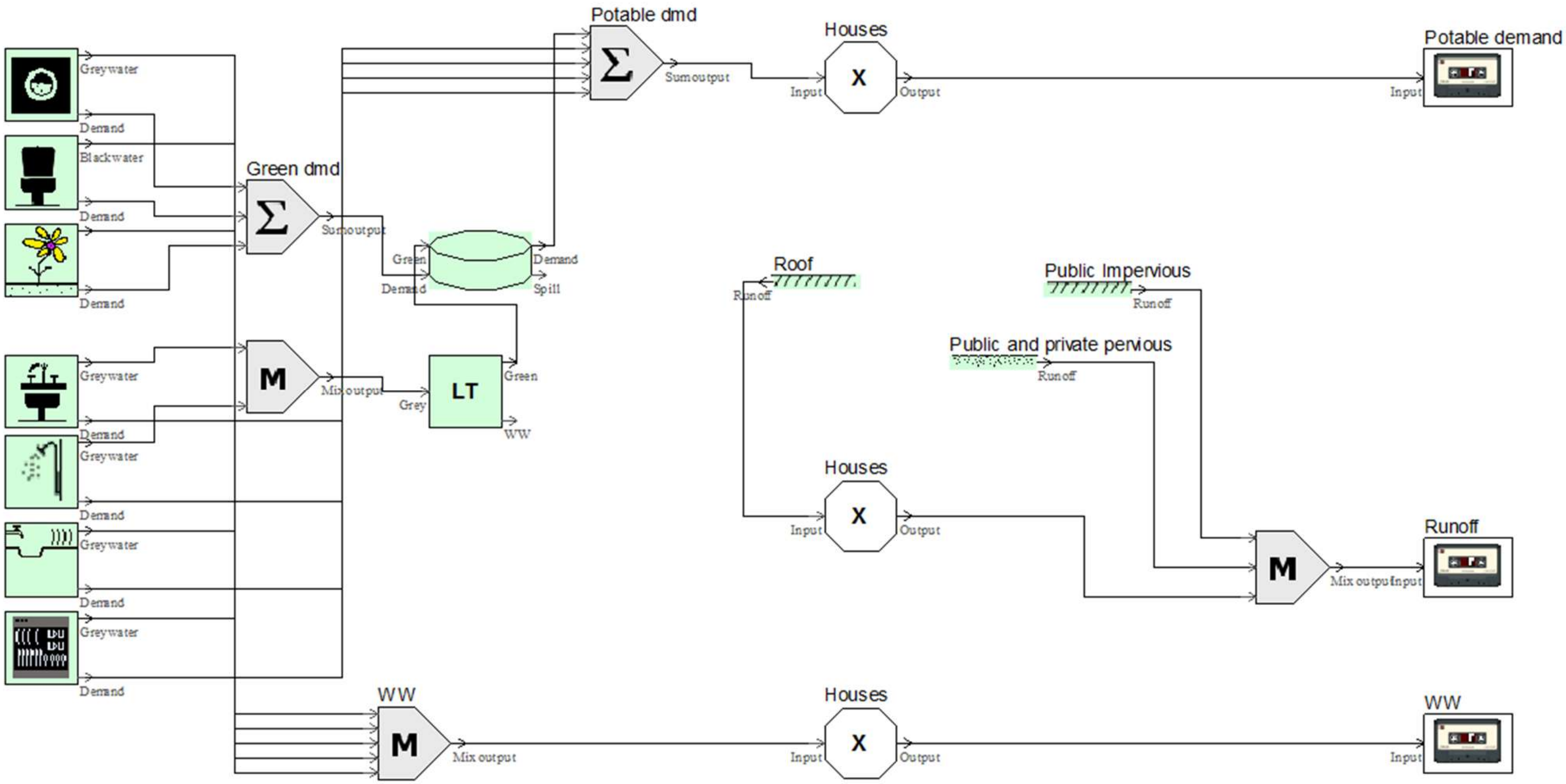
Configuration 2 – greywater recycling



The adoption rate of each technology (flow) depends:

- on the popularity of the adopted technology (word of mouth loop),
- on the number of the potential adopters (market saturation loop),
- on the GDP per capita trend (exogenous variable),
- and on the tariff (exogenous variable).

The stocks are:

- the number of users that adopted each one of the three technologies,
- and the number of potential adopters.

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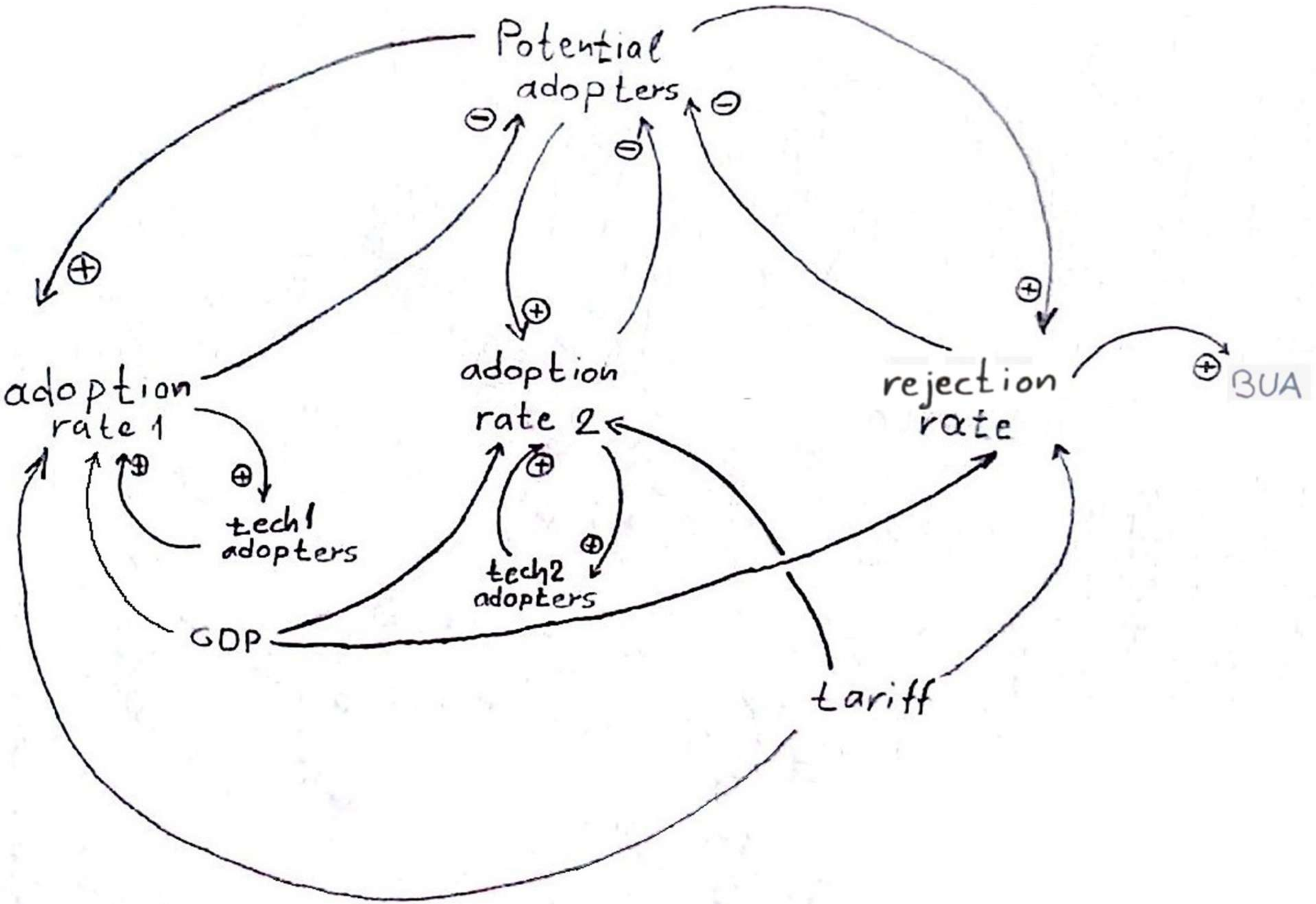
Causal loop diagram



$$Pbua_i = Pot_i / (Pot_i + Adp_i)$$

$$Imt_i = q\ Adp_i\ Pbua_i$$

$$Inv_i = p\ Pot_i$$

$$Adp_i = \sum(Inv_j + Imt_j), \text{ where } j=0,\ldots i$$

$$Pot_i = Pot_0 - \sum(Inv_j + Imt_j), \text{ where } j=0,\ldots i$$

Where, *i*: the time step index, Pbua: Probability that technology has not yet adopted, Pot: Potential adopters, Adp: Adopters, Imt: Imitators, Inv: Innovators, *q*: imitators coefficient, *p*: innovators coefficient.

The three innovator coefficients (*p*) were calibrated taking into account survey findings [1]: the willingness to adopt grey-water is 8.4%, the willingness to install/adopt BATNEEC water-saving devices or practices is 32%. This 40.4% (8.4+32) uptake is assumed to conclude after 10 years of the campaign initiation.

Imitator coefficient (*q*) was obtained from literature, equal to 0.3, which is the average of the values given in Table 1 [2].

GDP per capita trend is assumed to influence both adoption and rejection ratios. As guideline, the relation between GDP per capita and the increase of willingness-to-pay for biodiversity conservation [3]

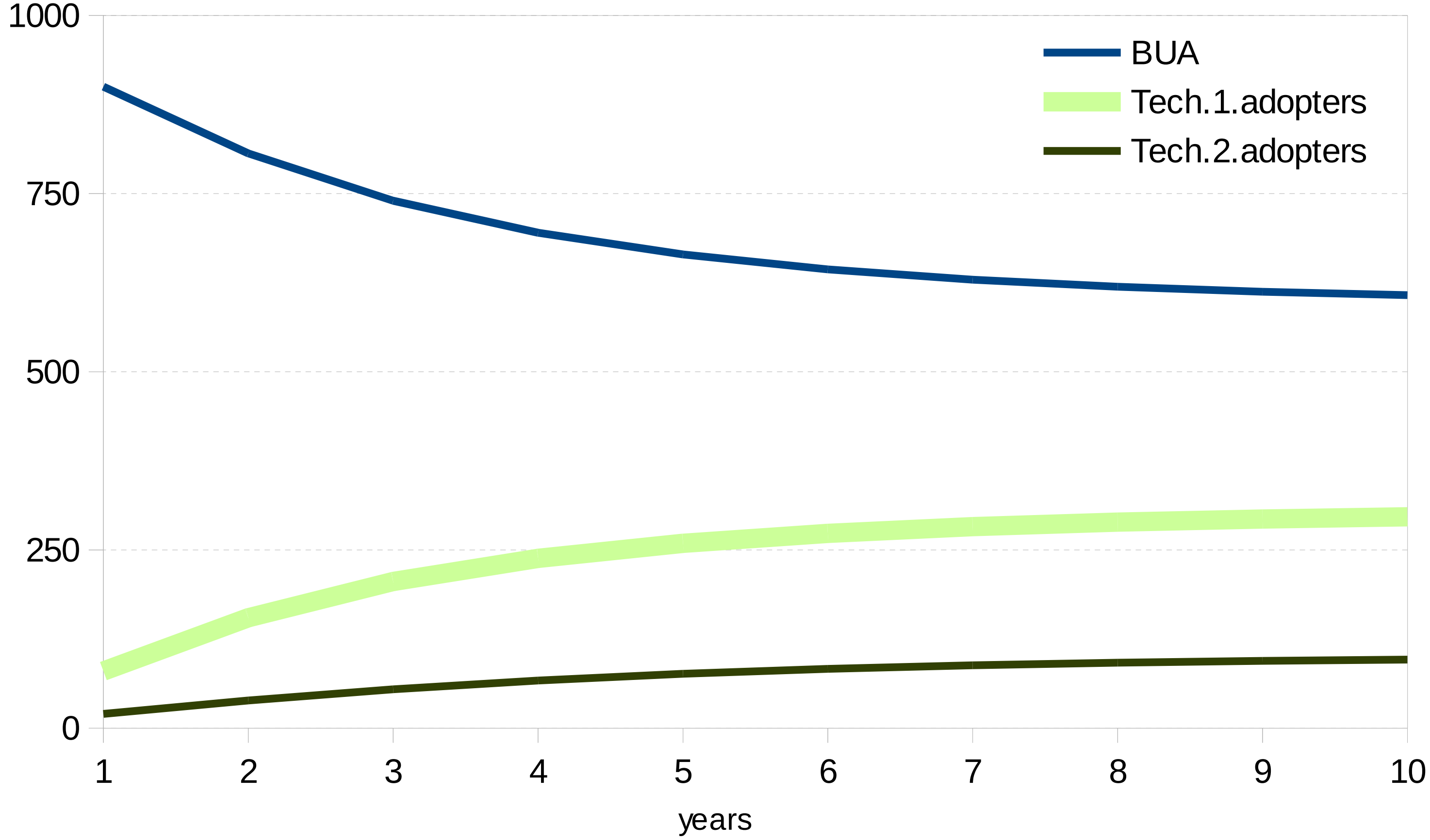
The trend of the GDP per capita is used to estimate the increase or decrease of the SD-flows.

Tariff increase is expected to result in demand reduction. For example, in Hungary an increase of tariff by 150% reduced demand by 30% [4]. In this study, it is assumed:

- similar social behavior,
- reduction attributed to new technologies only,
- a linear relationship between tariff and the change of SD-flows

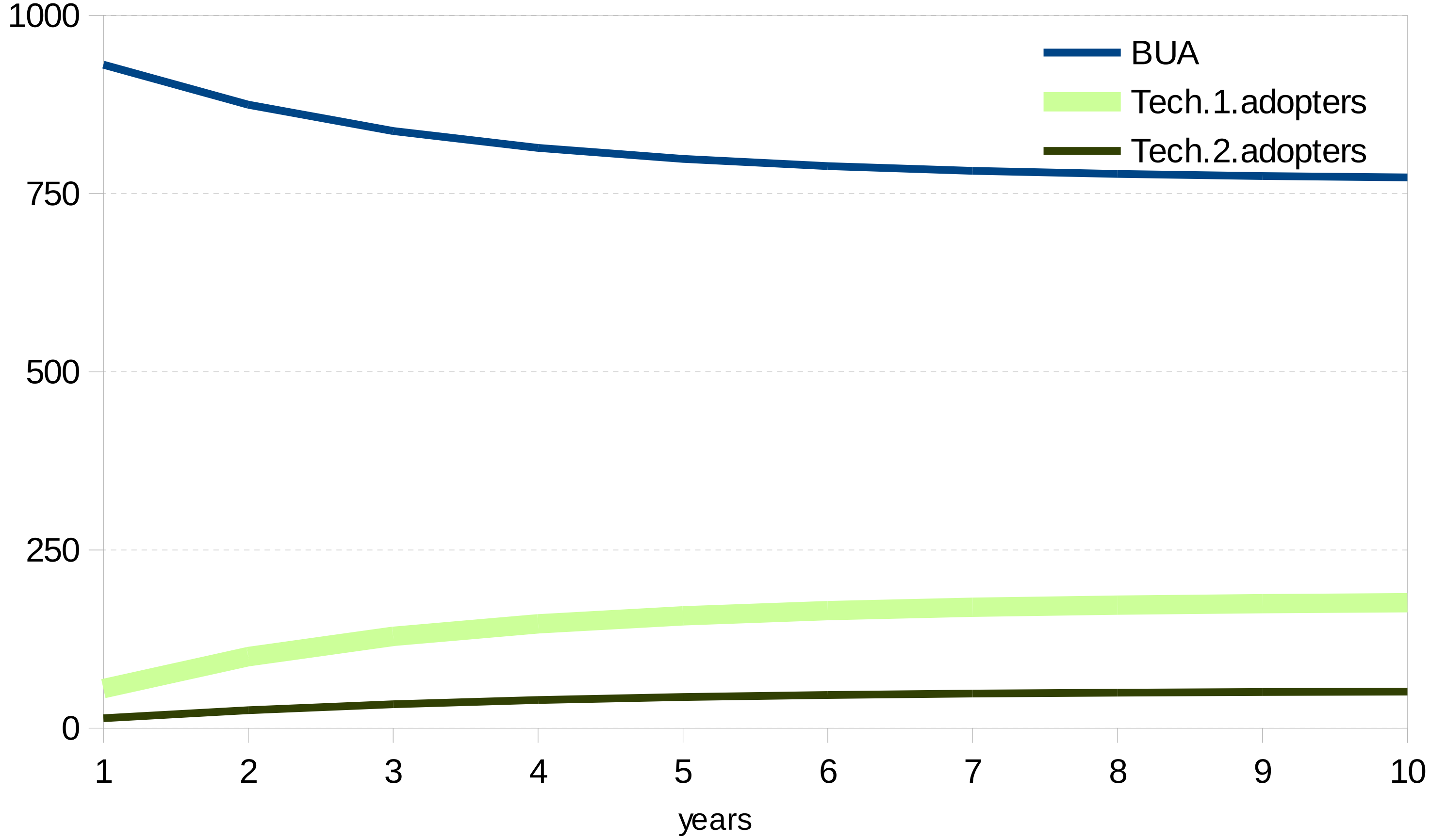
The parameter of this relationship is estimated with calibration (reproduce Hungary reduction).

Results – GDP/tariff constant



40% adopt of new technologies

Results – GPD decreases



23% adopt of new technologies

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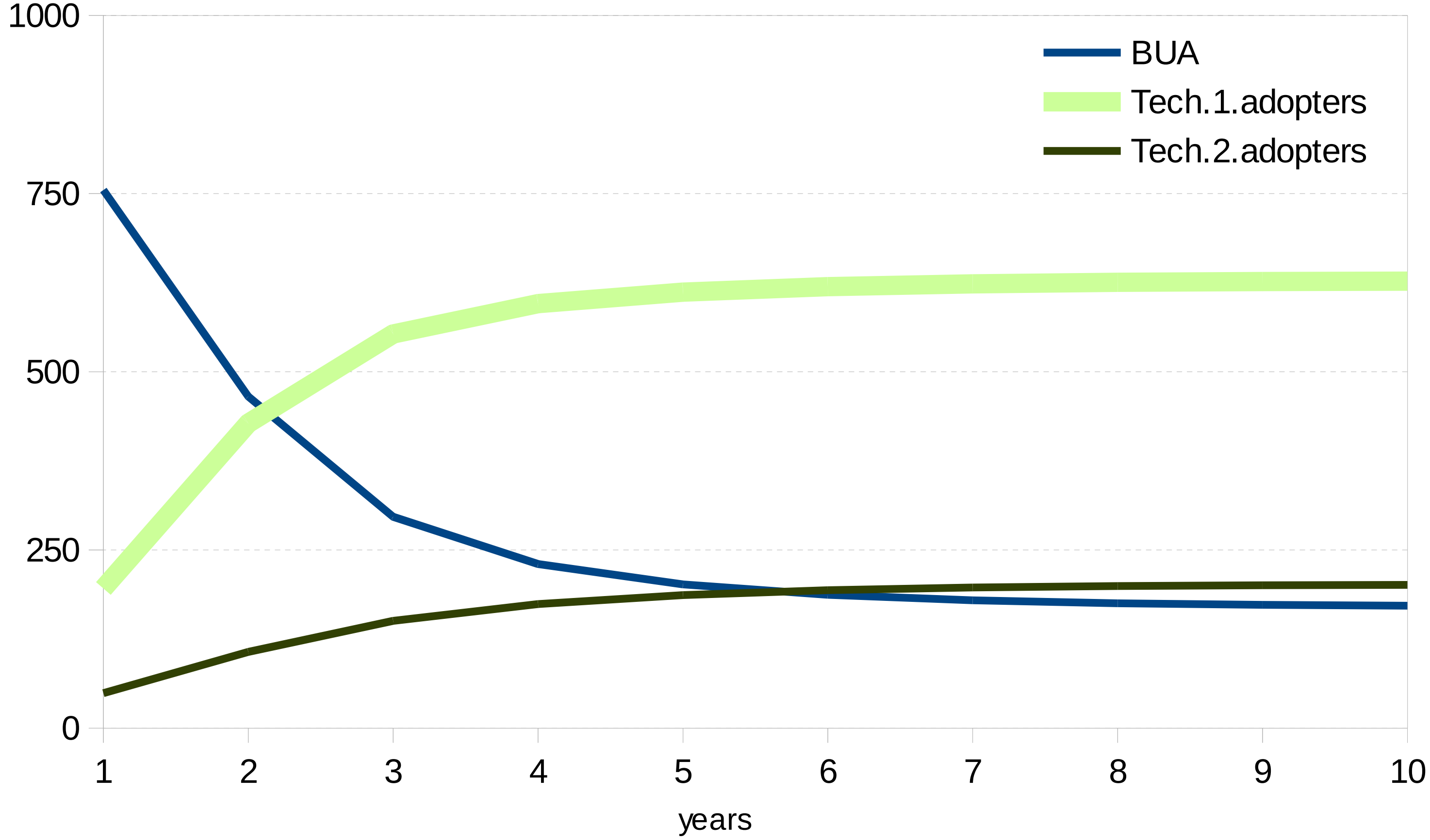
Results – 100% tariff increase



83% adopt new technologies.

The potable water demand of each one of the three technologies (including BUA) was estimated with the simulation of the representative household with UWOT (household characteristics correspond to South Attica typical household). The results are multiplied by the number of households that adopted each technology, as it is estimated with the SD simulation. This gives the potable water demand at the regional level.

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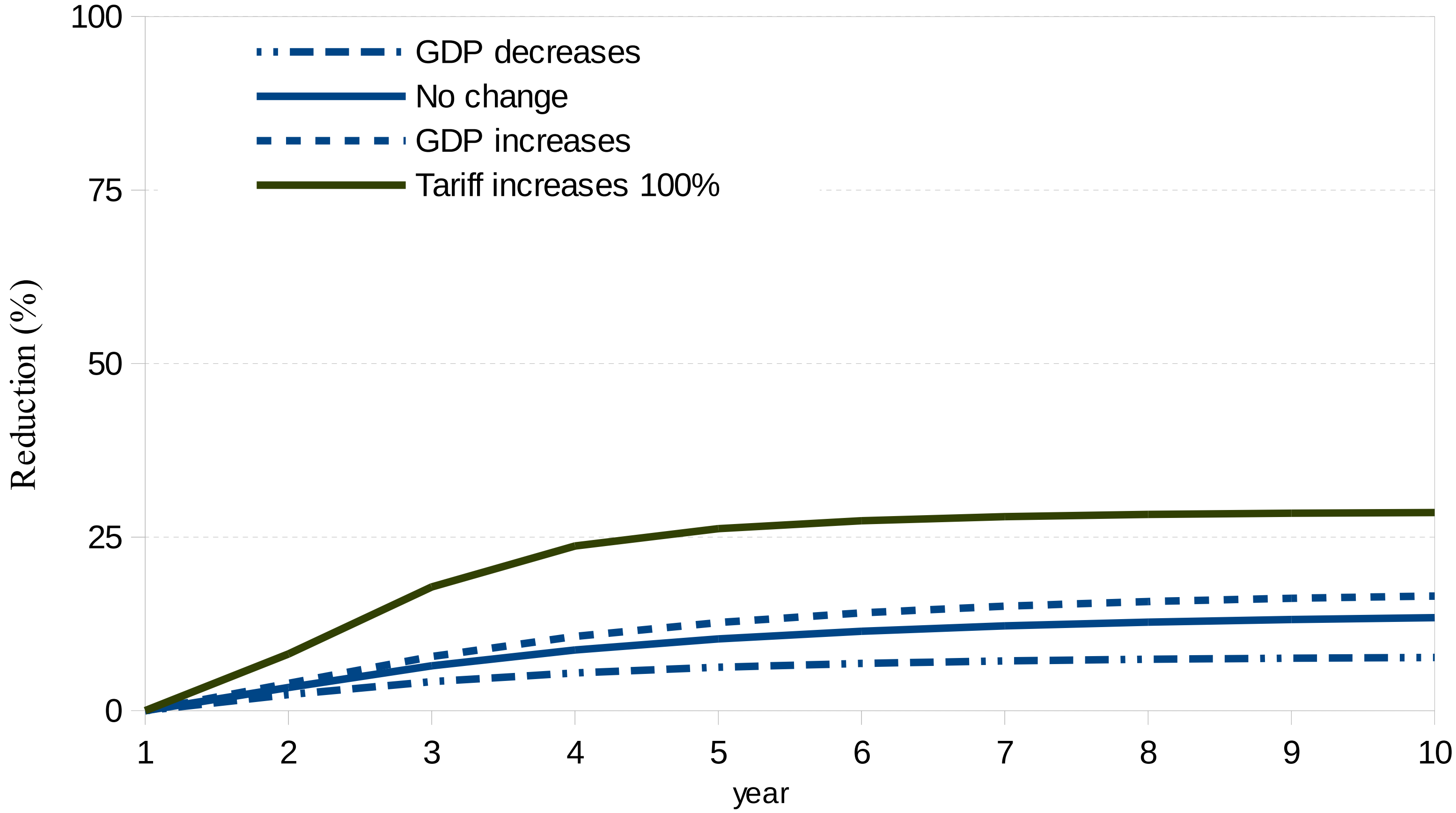
Results – potable demand and socio-economic scenarios



An urban water cycle model (UWOT) was coupled with a system dynamics model. UWOT simulated the representative household of each configuration. The results were combined with that of the system dynamics model to investigate the evolution of potable water demand as it is formed by alternative socio-economic scenarios.

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[1] ΥδρόΠολη (2013), παραδοτέο 4.1.1

[2] Bass, F.M. (1969). A New Product Growth Model for Consumer Durables. Management Science 15(5), 215–227.

[3] Jacobsen, J.B., and Hanley N. (2009). Are There Income Effects on Global Willingness to Pay for Biodiversity Conservation?, Environmental and Resource Economics June 2009, Volume 43, Issue 2, pp 137-160.

[4] European Environment Agency, Indicator factsheet: (WQ05) Water prices, 2013.