Exploring Farmers' Groundwater Use Patterns with an Agent-based Modeling Approach
Case study: Qazvin Irrigation Network Area

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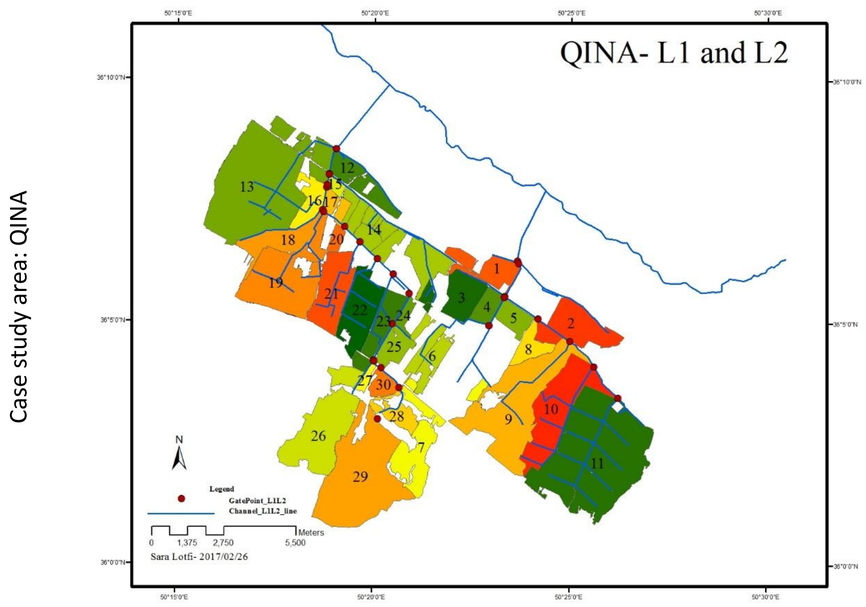
Introduction

- Iran is located in an arid and semi-arid region with growing population and though growing water demand in both municipal and agricultural sectors.
- Groundwater depletion is one of the main issues in Iran.
- Many aquifers have been banned for further abstraction since many years ago.
- Effective policies are needed to not only stop groundwater resources dropdown but also recover groundwater storage.
- We think the policies should be adopted with regard to local situation and users behaviours and properties.

Case Study

- Qazvin plain is located in central of Iran in which groundwater depletion has been an issue since 35 years ago.
- Groundwater level has been lowered more than 10 meters in last 15 years.
- Part of this plain is covered with Qazvin Irrigation Network Area (QINA) that is well-known as a modern irrigation system in Iran.
- The farmers have access to surface water through canals, from a dam outside the area and groundwater resources.
- First two sub-canals of this area is the case study that is around 13000 ha.
- Statistics show that irrigation accounts at most 30 percent of the cultivation cost by the farmers.
- Unfair distribution of canal water rights with respect to the field area besides the decrease in surface water allocation to QINA has led the farmers to rely on groundwater resources (and even extract more that they are allowed) to supply their irrigation demand.
- Interviews with the farmers show weak monitoring system in the area is the main reason for over tapping groundwater resources by users.



Methods

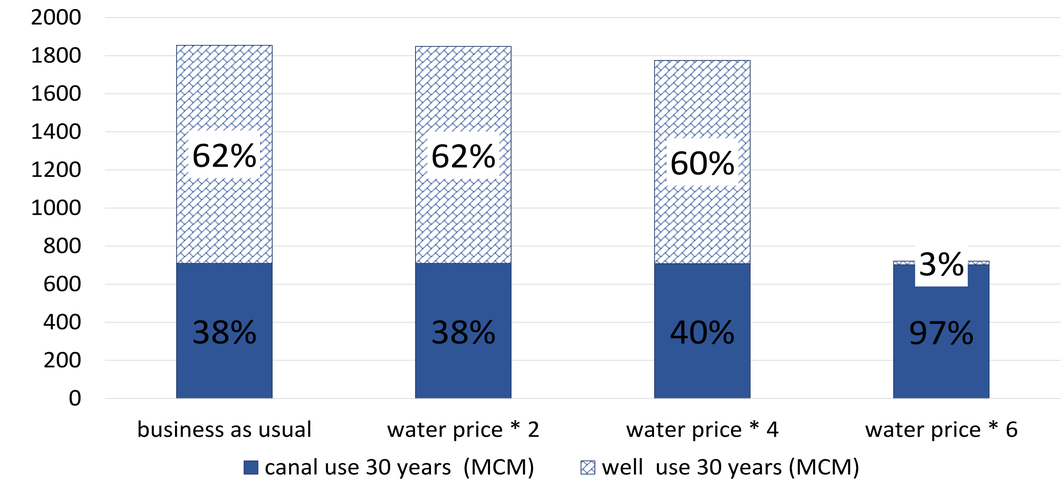
- An agent-based model is developed to explore the effectiveness of different policies in QINA to save groundwater resources by accounting farmers behaviours and properties.
- The farmers/ agents are clustered into four main groups based on their respective water resource access to their field area:
  - Cluster 1- Farmers who have plenty of access to both surface and groundwater resources.
  - Cluster 2- Farmers who have plenty of access to canal but not groundwater.
  - Cluster 3- Farmers who have access to plenty of groundwater but not canal.
  - Cluster 4- Farmers who do not have plenty of access to canal and groundwater.
- Farmers cultivate crops two times a year: Fall and Spring
- In each cultivation season the farmers decide about the area allocated to the crop they intend to cultivate while they do not allocate more than 30 percent of their field area to spring crops.

Scenarios:

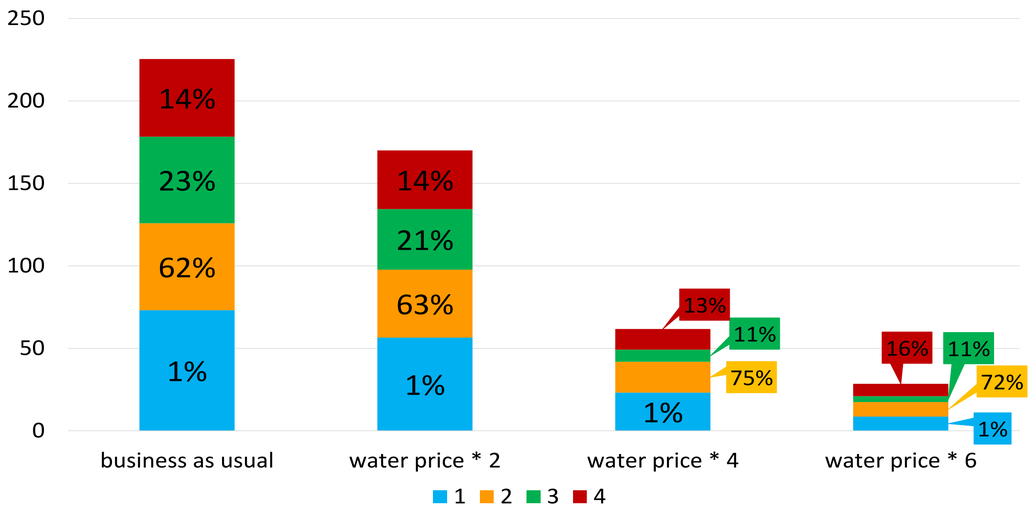
1-Business as usual
2- Twofold rise in water price
3- Fourfold rise in water price
4- Six fold rise in water price

Results

In figure below, the results of four scenarios are compared with regard to water use. Each column shows the water use in each scenario while the percentage of surface and groundwater use is labeled on them.
The results show as the price of water increases the amount of water used for irrigation decreases. As surface water costs half of groundwater, the amount of surface water used by the farmers does not decrease. In the last scenario, with six-fold increase in water price, the amount of groundwater use decreases substantially.



The figure below shows the amount of fund that farmers will have in 30 years. It shows the farmers gain less profit as the price of water increases. In this figure, the share of each farmer from the fund gained in the study area is labelled on the figure in per cent, too. The results show with rise in groundwater price, the farmers will gain less profit while the share of different clusters of farmers, from the gained profit, changes.



Conclusions

The results showed that with an increase in water price, the amount of water used by farmers decreases while they gain less profit. As canal price is less than groundwater price, water pricing policy mostly affects groundwater use which is the main concern. Also this policy affects farmers who are more dependent on groundwater resources than surface water and thus their share from the profit decreases with rise in water price.

Recommendations:

1- Although this policy seems effective but there should be some other side-policies, like effective monitoring system, to make farmers follow this policy.
2- It is recommended that policy makers think of compensation polices to help farmers with their profit loss.
3- This policy may affect different clusters of farmers differently. The farmers who mainly rely on groundwater resources for irrigation are affected more than the others. As a result it is recommended that policy makers pay attention on diverse effect of this policy on different stakeholders.

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