Innovative and Sustainable Groundwater Management in the Mediterranean

D6.3 Atlas of the Maps Produced Using the DSS

VERSION 1.1

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0.1	27/07/2023	Creation	Emmanouil Varouchakis
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Executive Summary

The overall objective of the InTheMED project is to implement innovative and sustainable management tools and remediation strategies for MED aquifers (inland and coastal) in order to mitigate anthropogenic and climate-change threats by creating new long-lasting spaces of social learning among different interdependent stakeholders, NGOs, and scientific researchers in five field case studies. These are located at the two shores of the MED basin, namely in Spain, Greece, Portugal, Tunisia, and Turkey.

InTheMED will develop an inclusive process that will establish an ensemble of innovative assessment and management tools and methodologies including a high-resolution monitoring approach, smart modelling, a socio-economic assessment, web-based decision support systems (DSS) and new configurations for governance to validate efficient and sustainable integrated groundwater management in the MED considering both the quantitative and qualitative aspects.

Deliverable D6.3, is part of Task 6.3 "Production of maps from the DSS according to suggested scenarios and dissemination with stakeholders" (Lead: TUC, participants: UPV, UFZ, IST-ID, CERTE and BU). The objective of the current document is to present the Atlas of the maps that was produced with the use of the DSS tool. The presented maps were based on indicative scenarios, suggested by the research teams. The tool is accessible to the interested users through a web application, so any user can retrieve their maps of interest based on their own scenarios.

1. Introduction

The "Atlas of Groundwater Level Maps" represents a pivotal advancement for the study areas of InTheMED project for the sustainable management of the groundwater resources which are increasingly strained. This innovative atlas provides the potential of the Decision Support System (DSS) platform driven by fuzzy logic, which was developed to fulfil the aim and scope of InTheMED project (Anyfanti et al., 2021, 2022), offering a comprehensive and user-friendly platform for stakeholders engaged in groundwater management. The Atlas of Maps presented in the following section is the output of the DSS platform providing a series of groundwater variation maps based on the management scenarios suggested as good practice in each study site.

The groundwater management scenarios were individually suggested for each case study based on the characteristics and the water needs of each area:

- In Requena-Utiel (Spain) the groundwater management scenarios were assessed by considering changes in recharge, primarily influenced by precipitation and pumping rates.
- In Tympaki (Greece) groundwater management scenarios were based on pumping rates, expected average groundwater level and precipitation variations.
- In Konya (Türkiye) precipitation variation scenarios and crop water demand in terms of a crop coefficient were assessed.

The suggested management scenarios were compared by means of groundwater level maps with the most recent groundwater level conditions in each case study (Todaro et al., 2023) in terms of a fuzzy logic approach to provide a comparison of the suggested good practice with the base management conditions in each case study. Two categories of fuzzy rules are applied in the DSS platform i) using absolute groundwater level values to designate variations and ii) using positive and negative values to designate increments or decrements. The results are individually presented for each case study and suggested scenario (Todaro et al., 2023) in the following section and are obtained in window format where next to each window one can identify the scenario assessed and the fuzzy logic approach selected.

2. Atlas of Groundwater Level Maps for Konya, Requena-Utiel and Tympaki

The Atlas of maps for the case studies considered in this project can be developed through the DSS tool implemented based on the surrogate groundwater models and the fuzzy logic approach and is accessible through the following link that includes a web application: https://inthemedprima.com/Results-DSS

The DSS tool can be obtained in three alternative ways. In case users have MATLAB installed, a MATLAB app is provided. Users simply have to install the "InTheMED" App into MATLAB "My Apps" and run the app through the MATLAB APPS tab. If users do not have MATLAB installed, they can download and install the MATLAB Runtime version, which fits their operating system for R2022b and then install and run the standalone MATLAB application. The benefit of this alternative is that users can run the standalone application for free without MATLAB licenses. The third alternative is a MATLAB Web App Server, through which end-users can access and run the web app using only a browser without installing additional software.

A series of scenarios from each case study based on the selected groundwater management scenarios considered in D3.4 (Todaro et al., 2023) that can be reproduced from the web DSS application are presented below and in the aforementioned website.

2.1. Konya Case Study

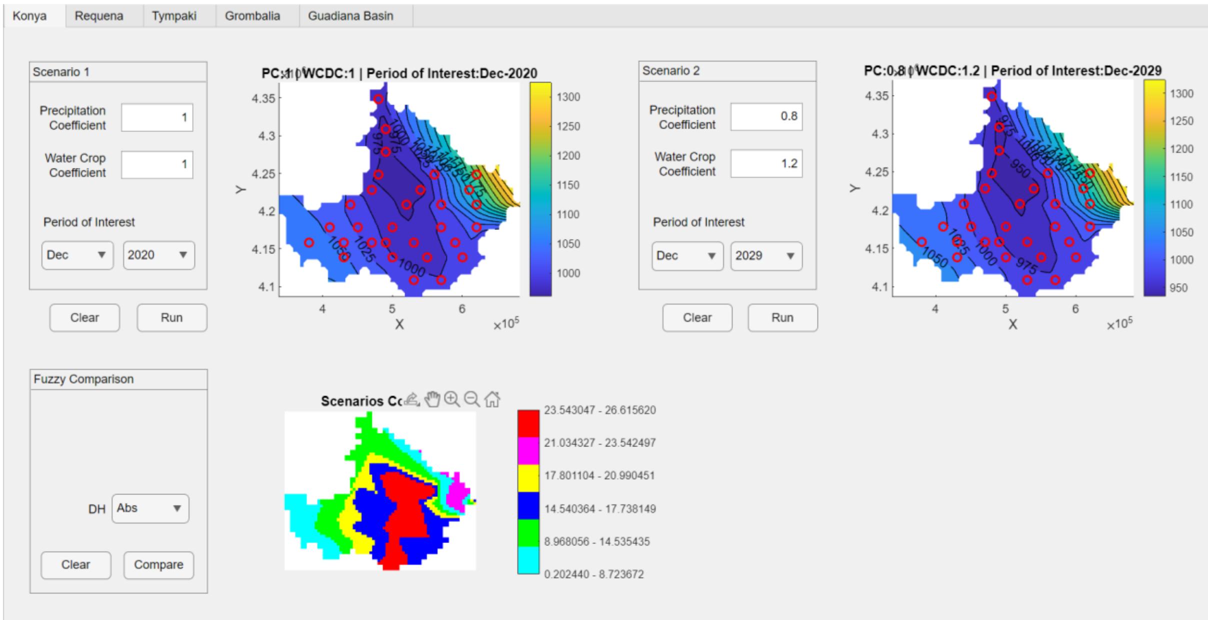

Figure 1. Konya study site – Precipitation Coefficient: 0.8, Water Crop Coefficient: 1.2, Period: Dec-2029

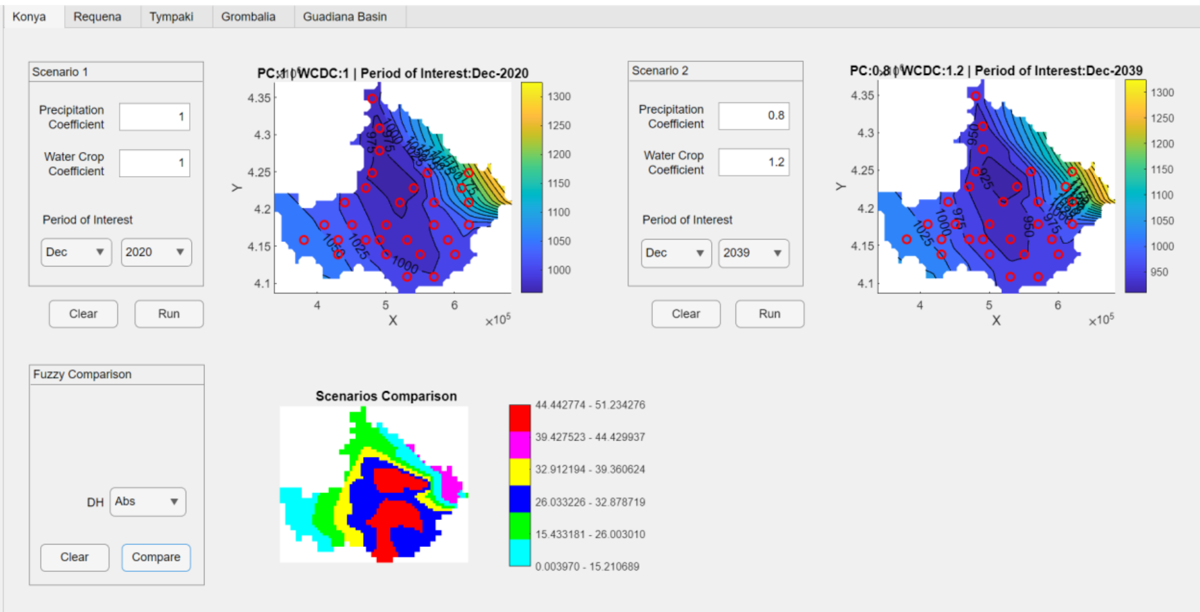

Figure 2. Konya study site – Precipitation Coefficient: 0.8, Water Crop Coefficient: 1.2, Period: Dec-2039

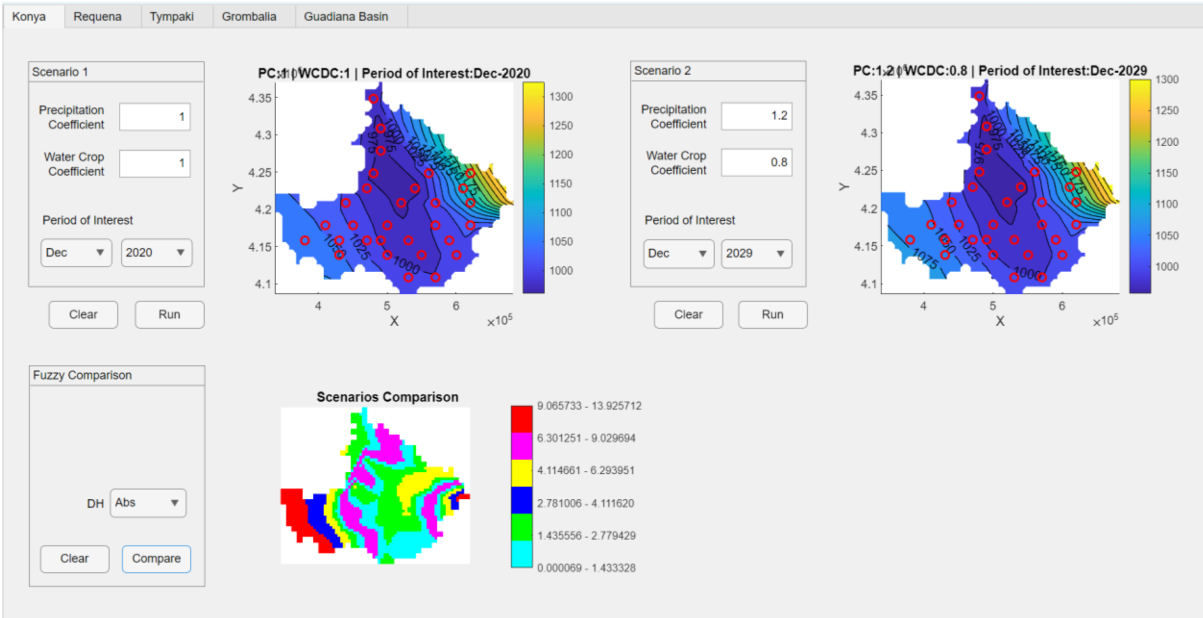

Figure 3. Konya study site – Precipitation Coefficient: 1.2, Water Crop Coefficient: 0.8, Period: Dec-2029

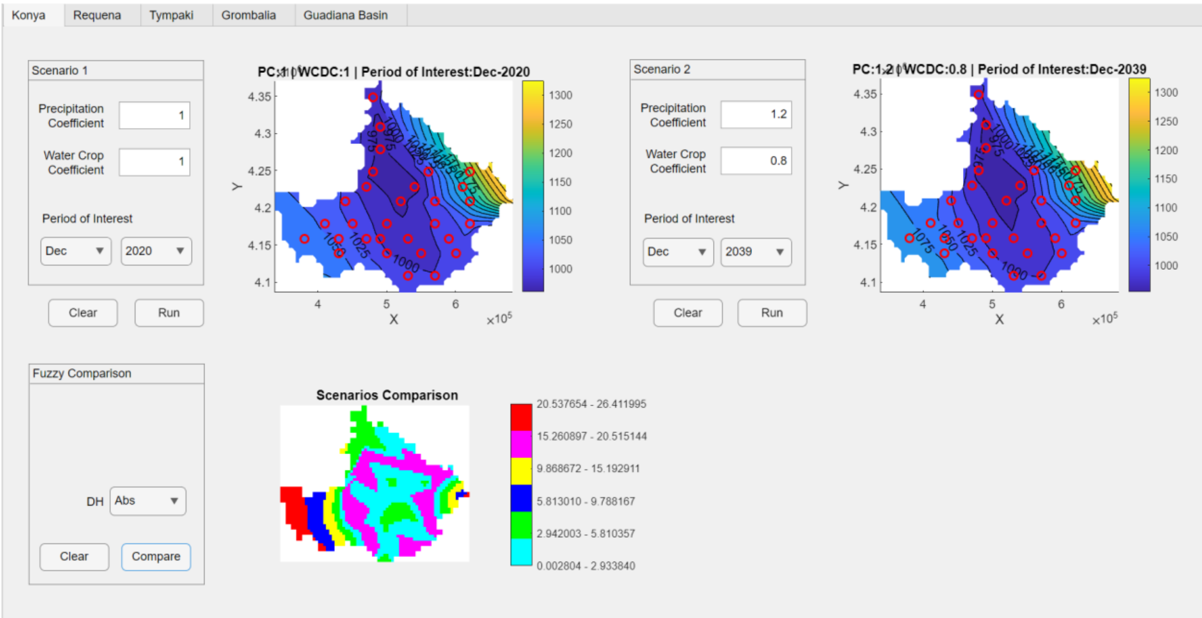

Figure 4. Konya study site – Precipitation Coefficient: 1.2, Water Crop Coefficient: 0.8, Period: Dec-2039

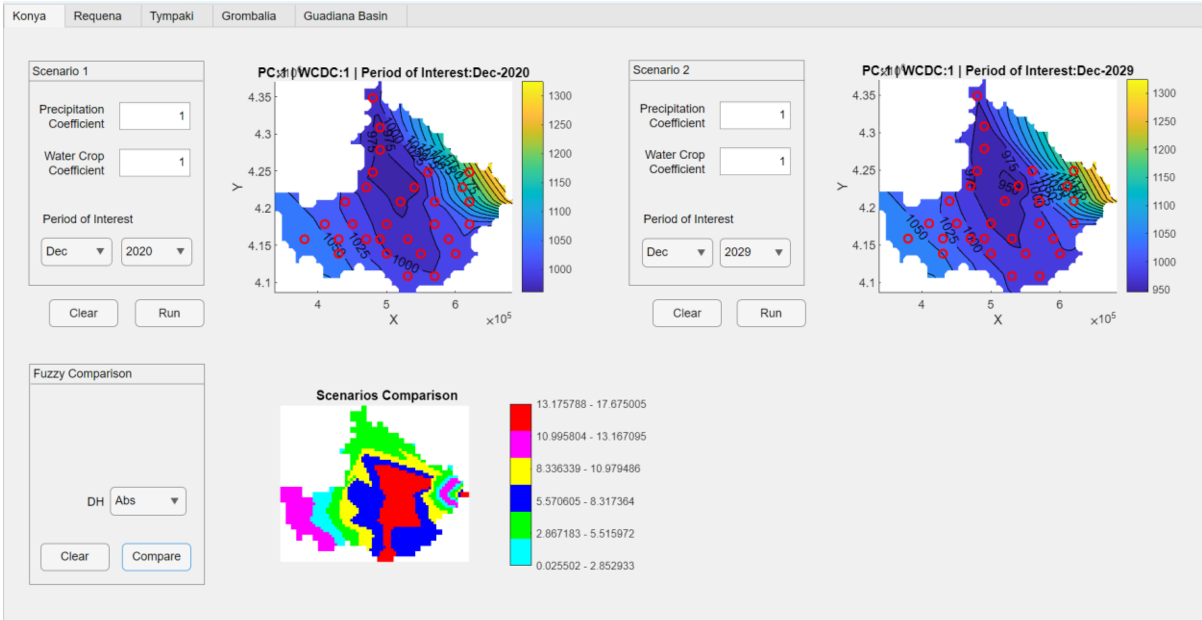

Figure 5. Konya study site – Precipitation Coefficient: 1, Water Crop Coefficient: 1, Period: Dec-2029

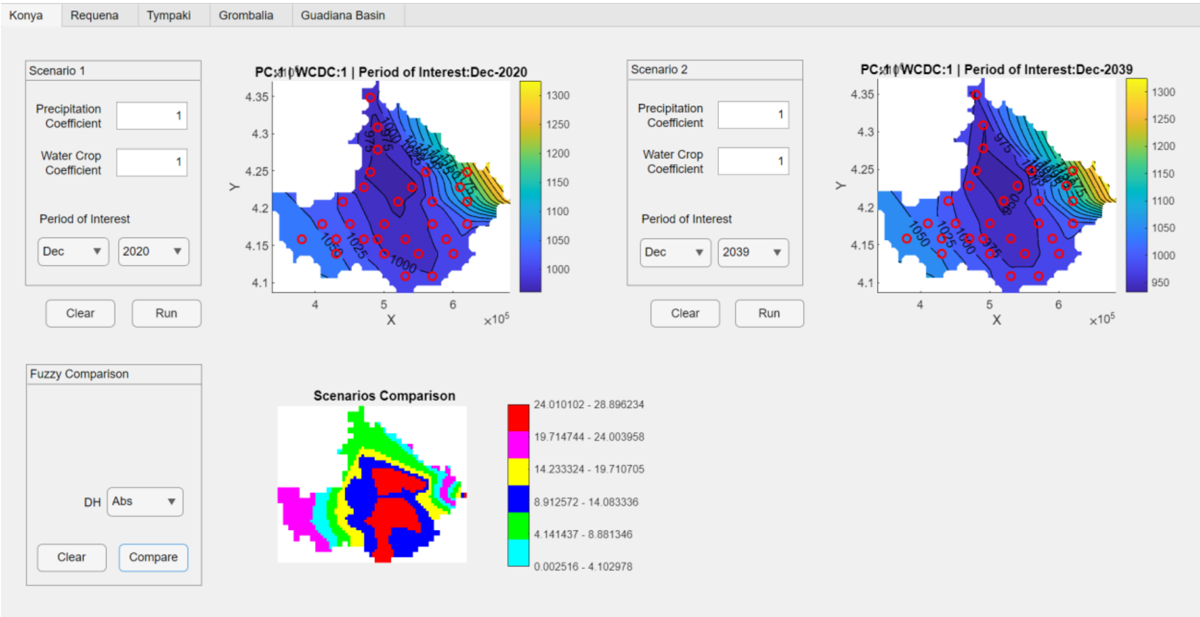

Figure 6. Konya study site – Precipitation Coefficient: 1, Water Crop Coefficient: 1, Period: Dec-2039

2.2. Requena-Utiel Case Study

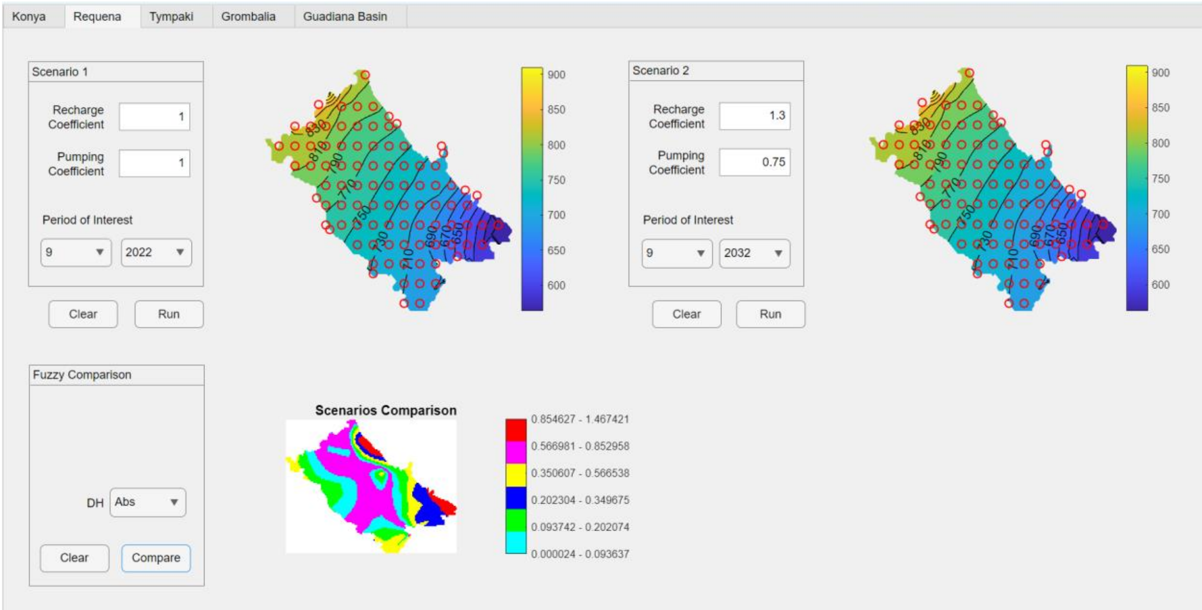

Figure 7. Requena study site – Recharge Coeff.: 1.3, Pumping Coeff.: 0.75, Period: Sep-2032, DH: Abs

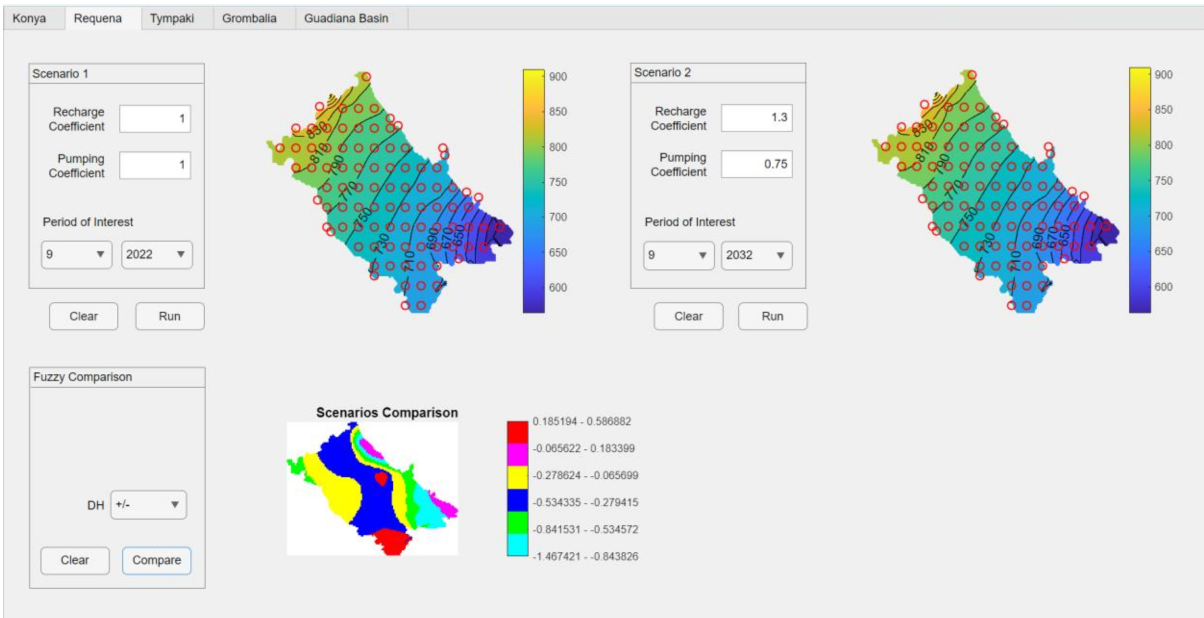

Figure 8. Requena study site – Recharge Coeff.: 1.3, Pumping Coeff.: 0.75, Period: Sep-2032, DH: +/-

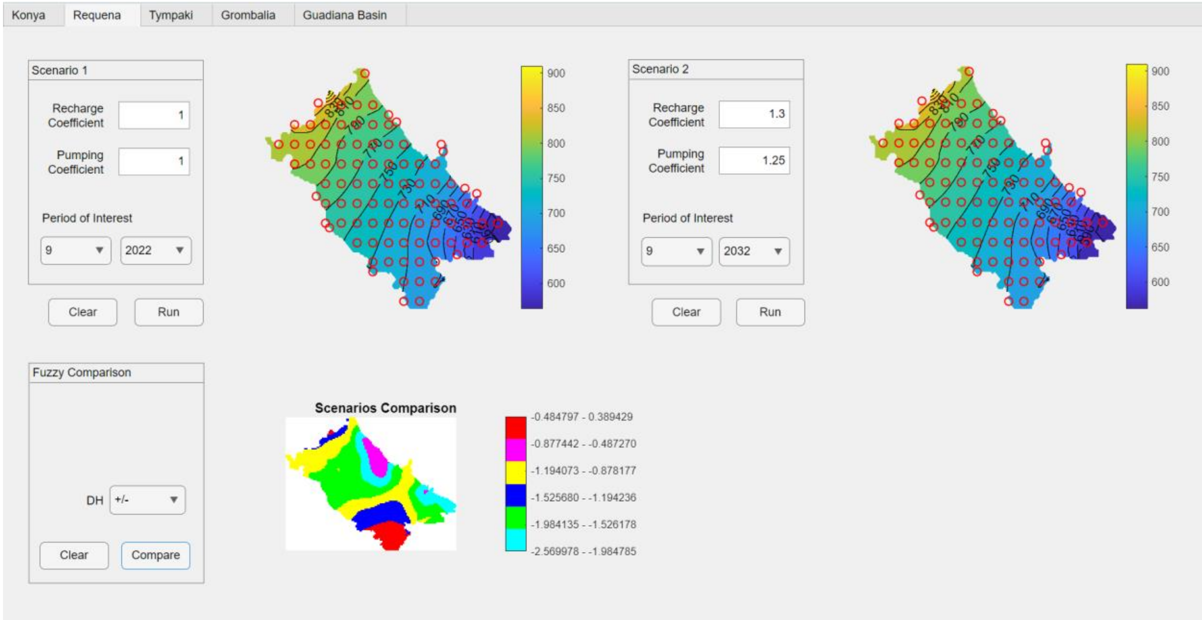

Figure 9. Requena study site – Recharge Coeff.: 1.3, Pumping Coeff.: 1.25, Period: Sep-2032, DH: +/-

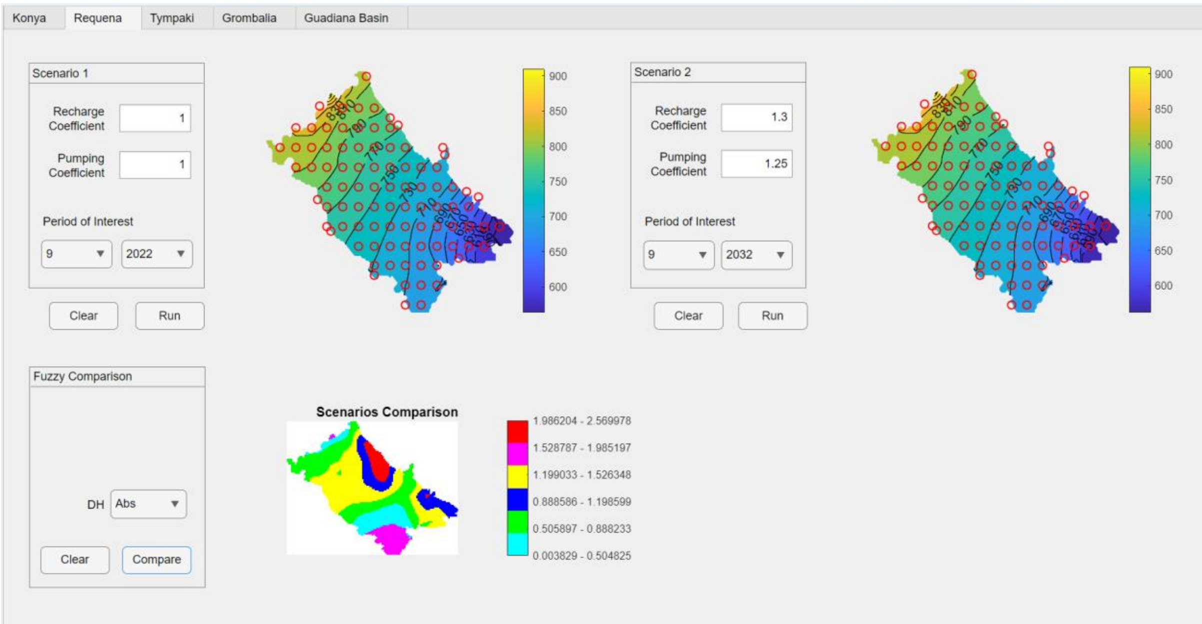

Figure 10. Requena study site – Recharge Coeff.: 1.3, Pumping Coeff.: 1.25, Period: Sep-2032, DH: Abs

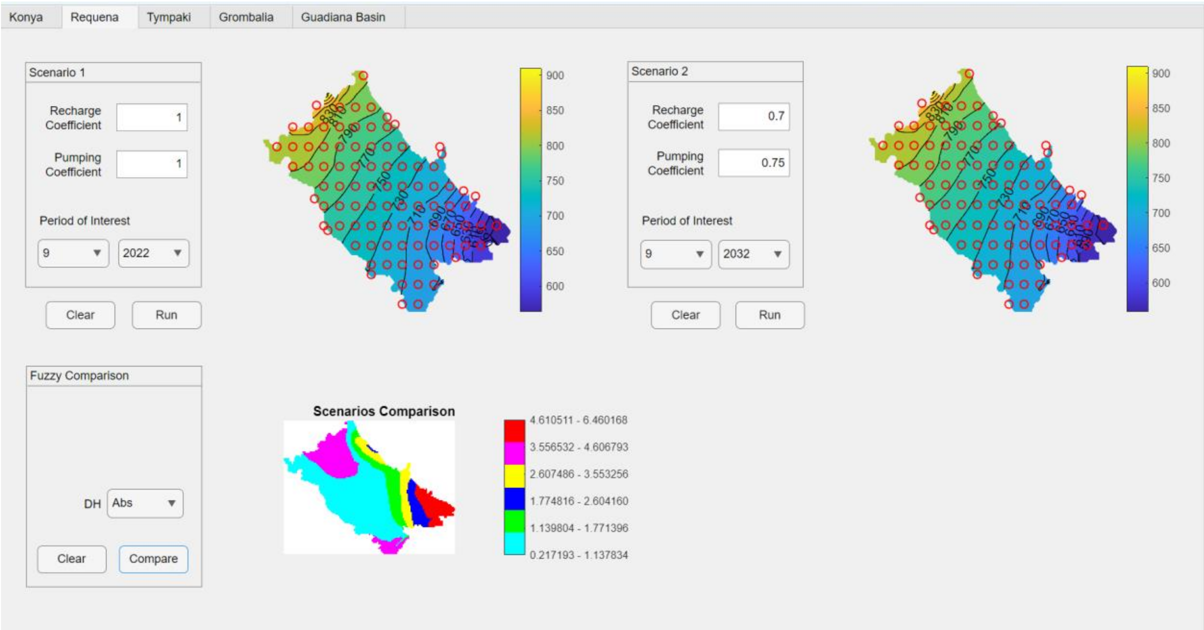

Figure 11. Requena study site – Recharge Coeff.: 0.7, Pumping Coeff.: 0.75, Period: Sep-2032, DH: Abs

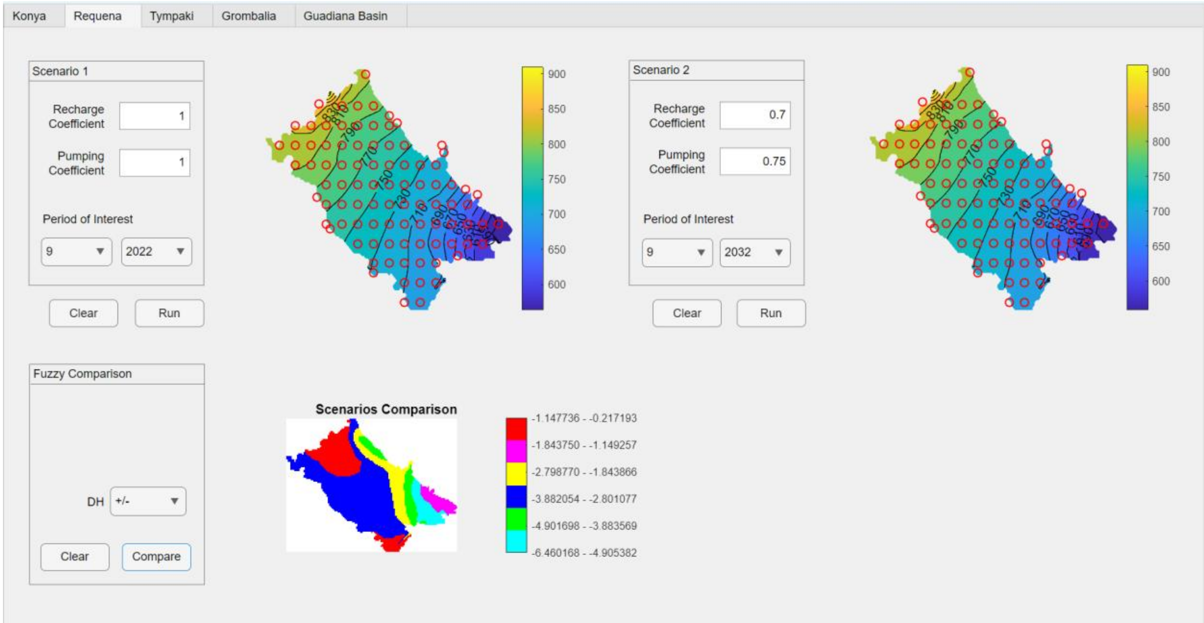

Figure 12. Requena study site – Recharge Coeff.: 0.7, Pumping Coeff.: 0.75, Period: Sep-2032, DH: +/-

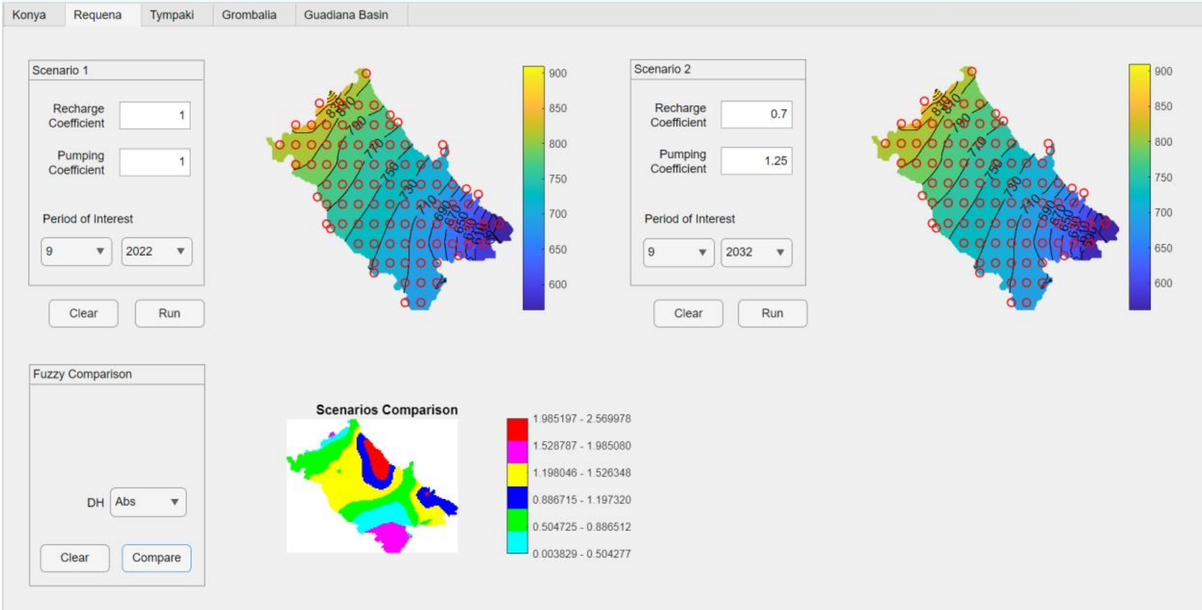

Figure 13. Requena study site – Recharge Coeff.: 0.7, Pumping Coeff.: 1.25, Period: Sep-2032, DH: Abs

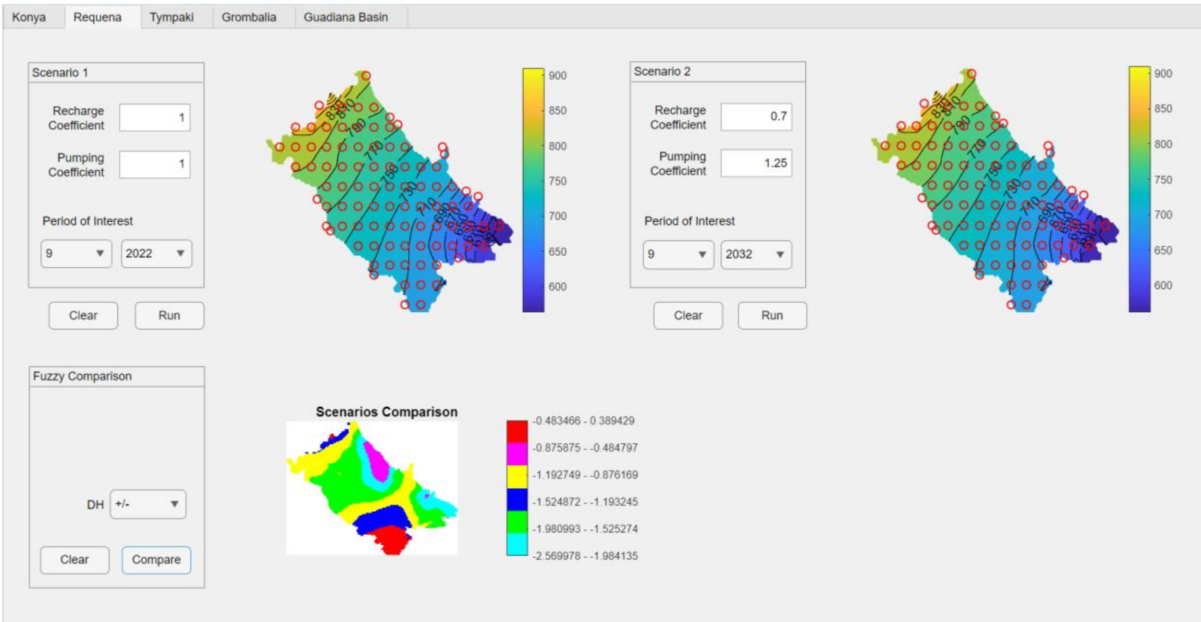

Figure 14. Requena study site – Recharge Coeff.: 0.7, Pumping Coeff.: 1.25, Period: Sep-2032, DH: +/-

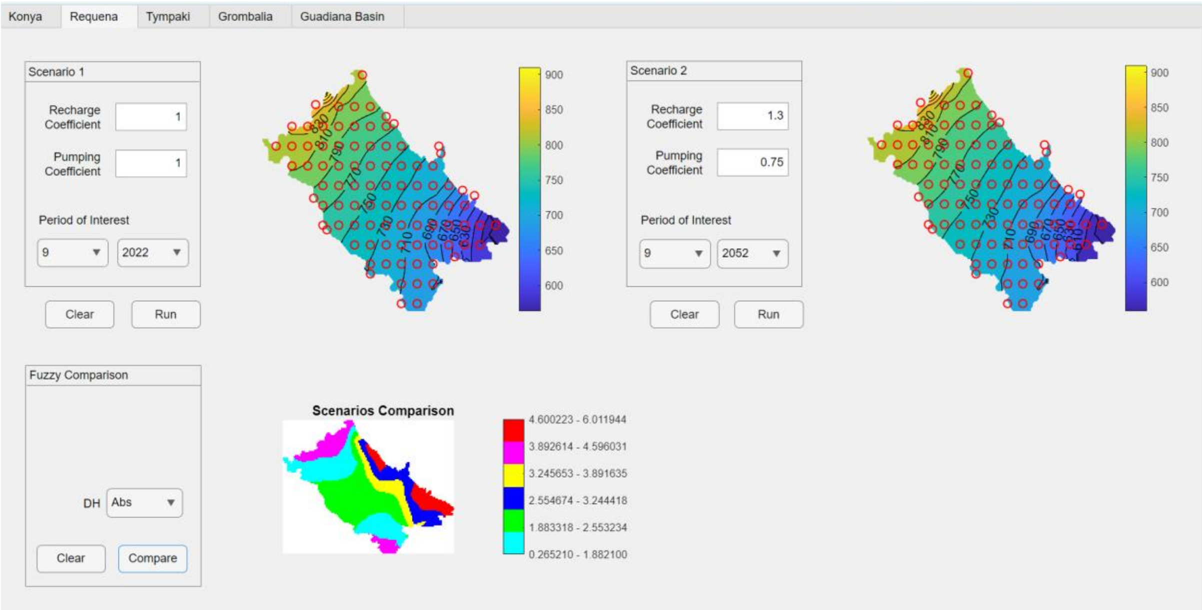

Figure 15. Requena study site – Recharge Coeff.: 1.3, Pumping Coeff.: 0.75, Period: Sep-2052, DH: Abs

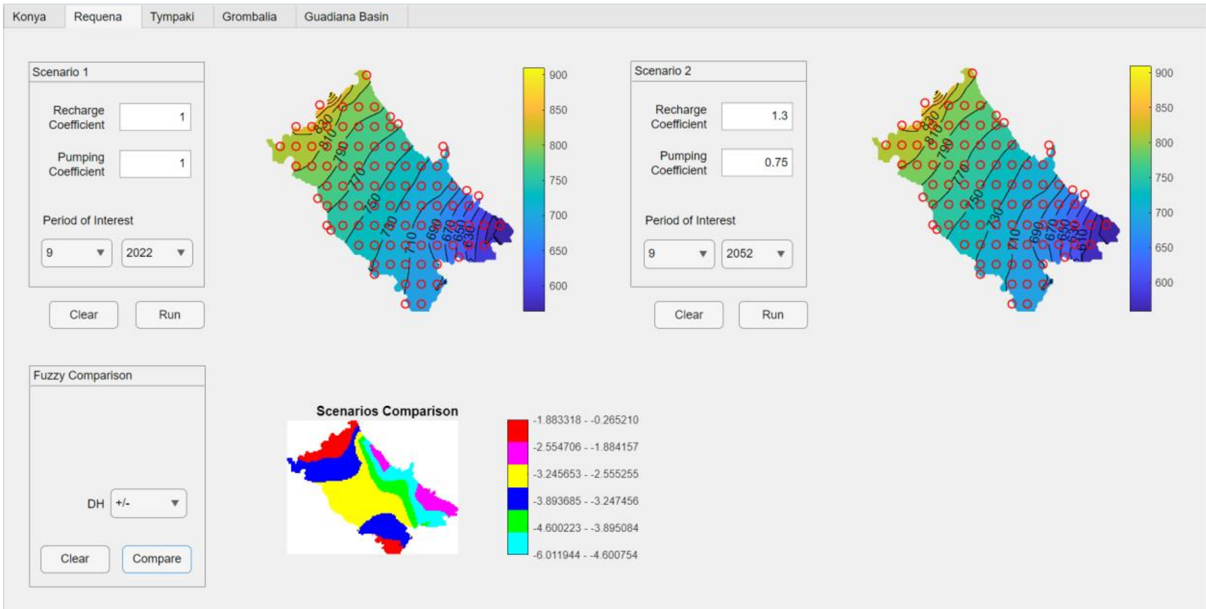

Figure 16. Requena study site – Recharge Coeff.: 1.3, Pumping Coeff.: 0.75, Period: Sep-2052, DH: +/-

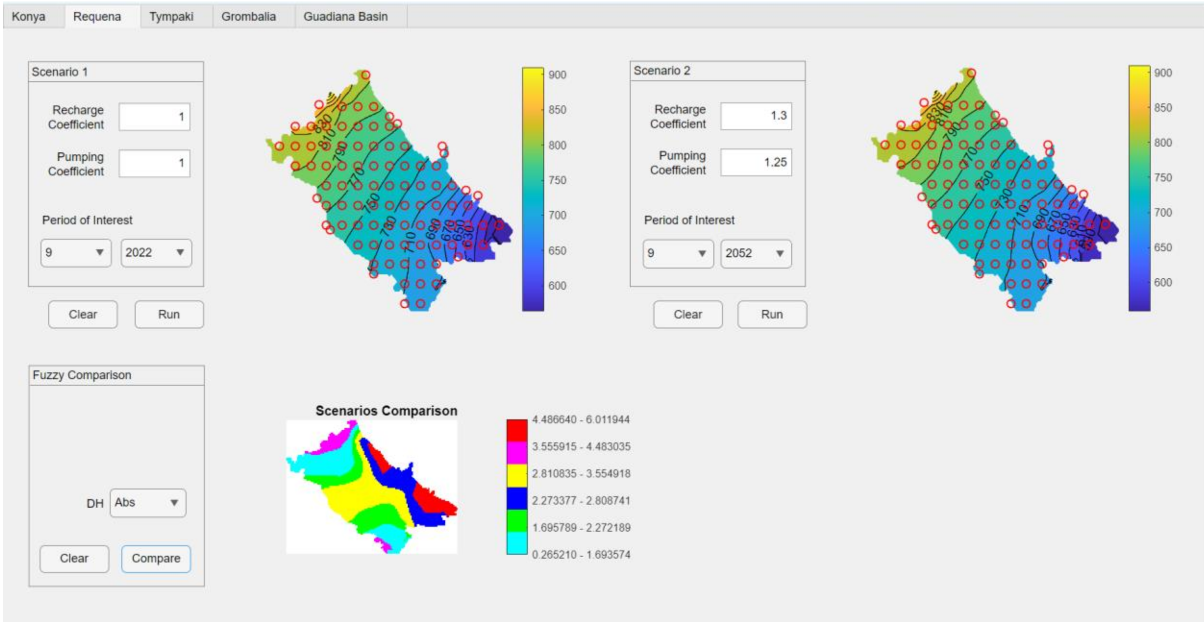

Figure 17. Requena study site – Recharge Coeff.: 1.3, Pumping Coeff.: 1.25, Period: Sep-2052, DH: Abs

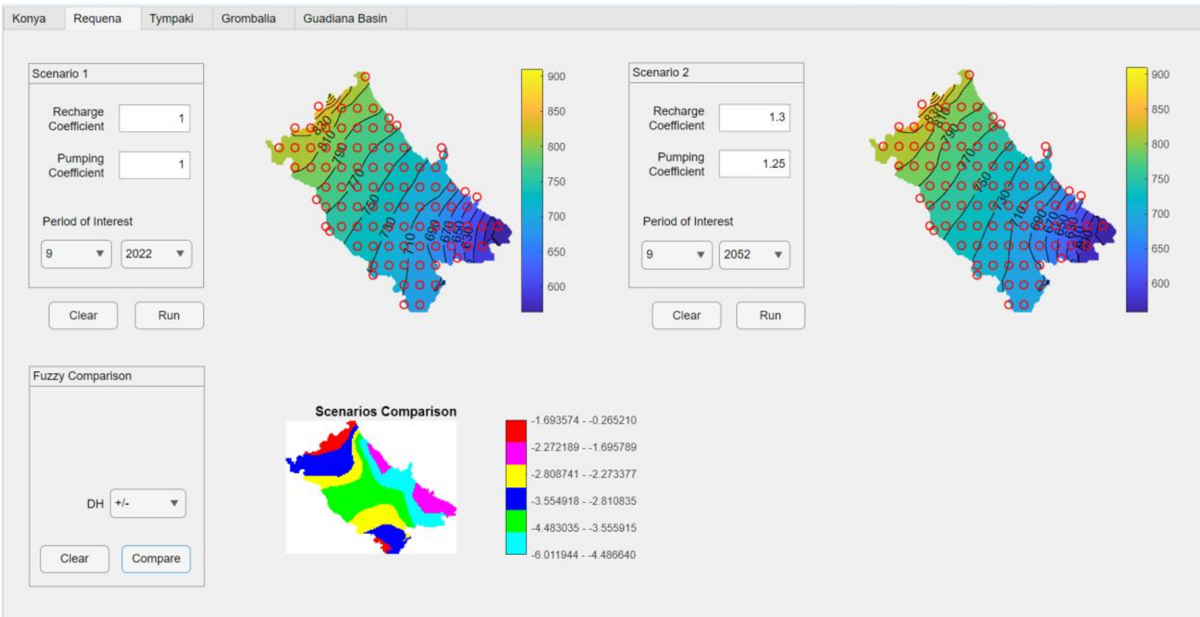

Figure 18. Requena study site – Recharge Coeff.: 1.3, Pumping Coeff.: 1.25, Period: Sep-2052, DH: +/-

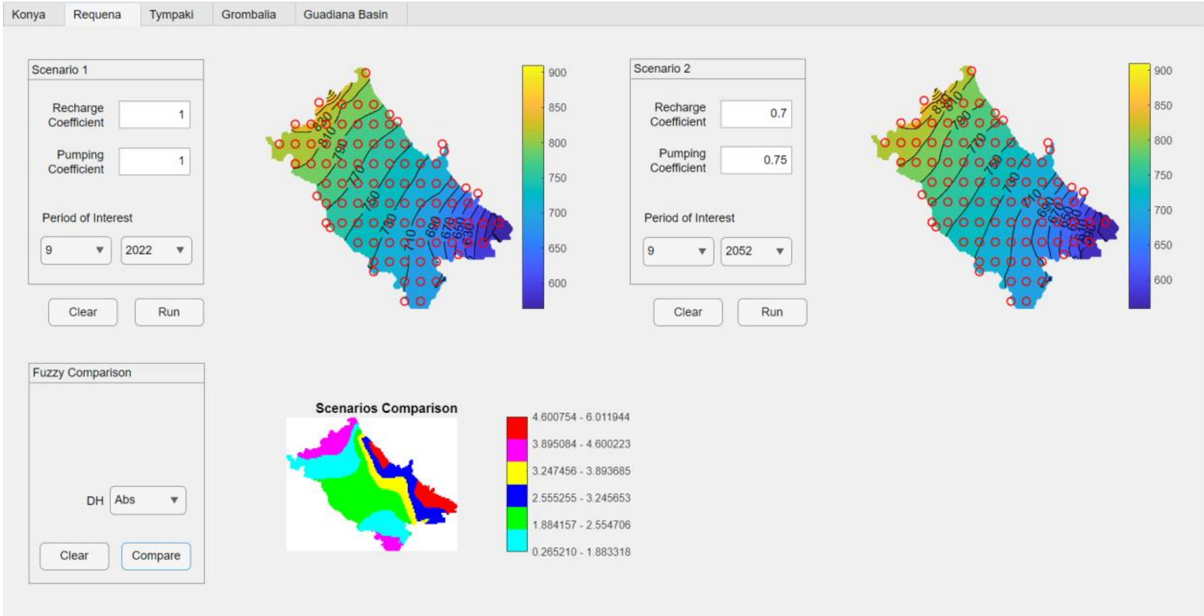

Figure 19. Requena study site – Recharge Coeff.: 0.7, Pumping Coeff.: 0.75, Period: Sep-2052, DH: Abs

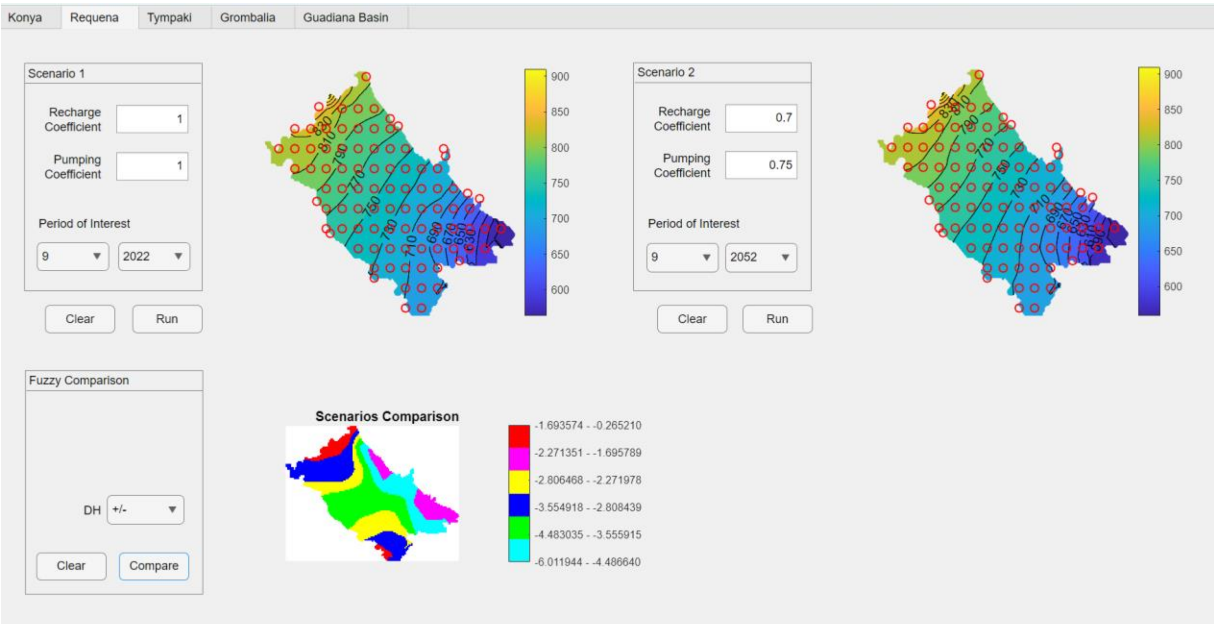

Figure 20. Requena study site – Recharge Coeff.: 0.7, Pumping Coeff.: 0.75, Period: Sep-2052, DH: +/-

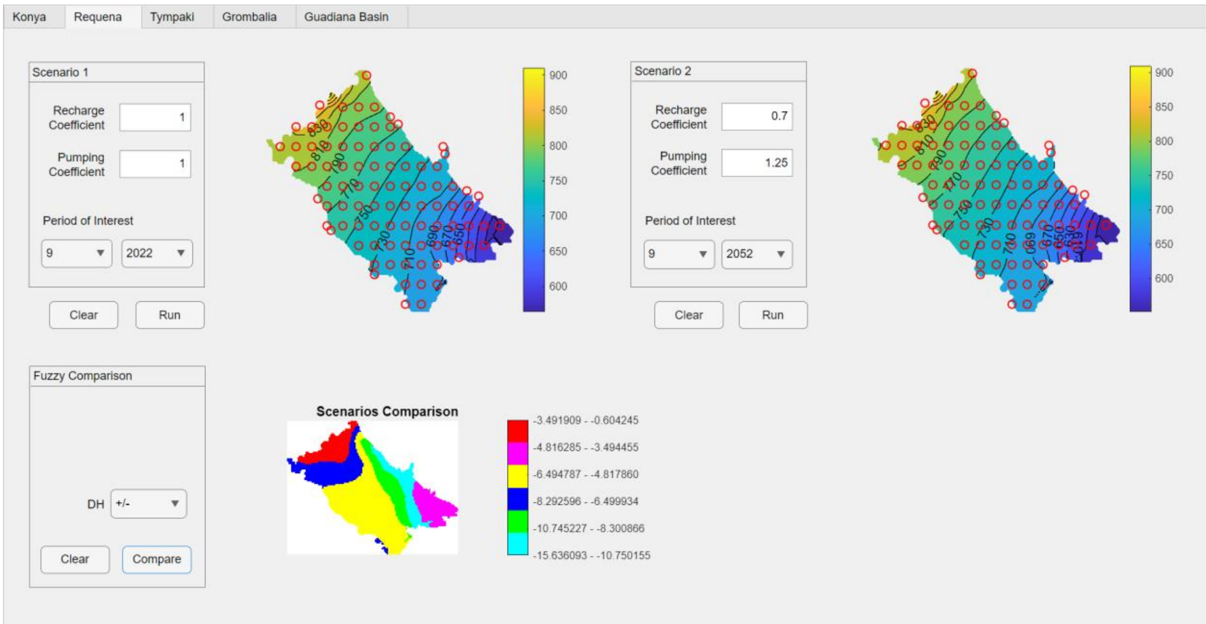

Figure 21. Requena study site – Recharge Coeff.: 0.7, Pumping Coeff.: 1.25, Period: Sep-2052, DH: +/-

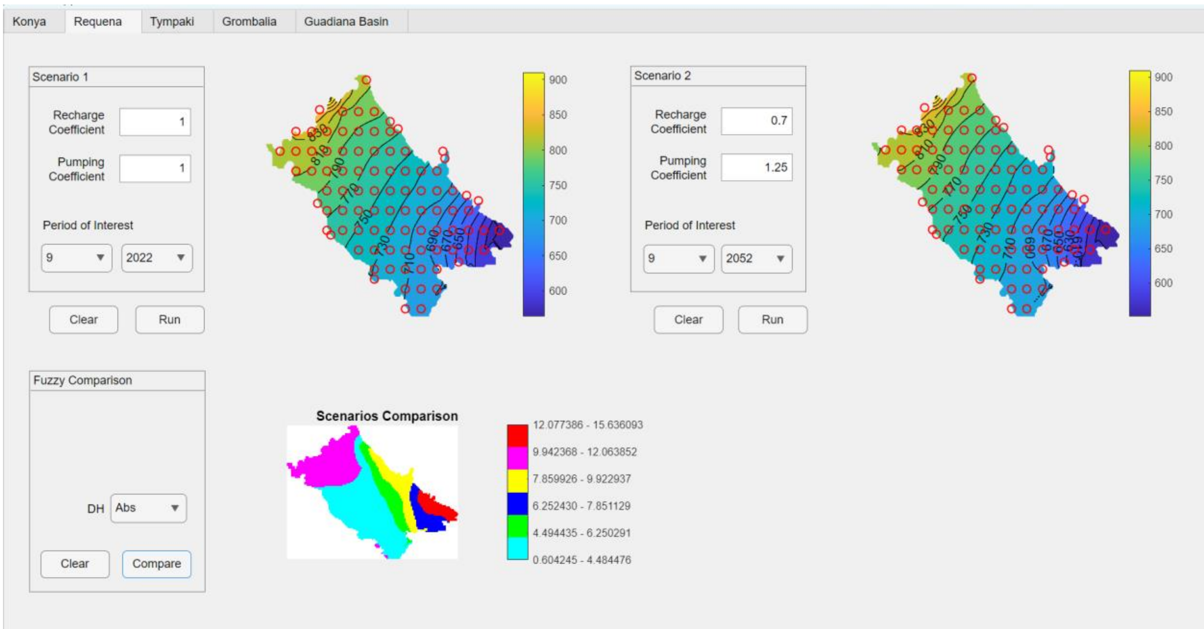

Figure 22. Requena study site – Recharge Coeff.: 0.7, Pumping Coeff.: 1.25, Period: Sep-2052, DH: Abs

2.3. Tympaki Case Study

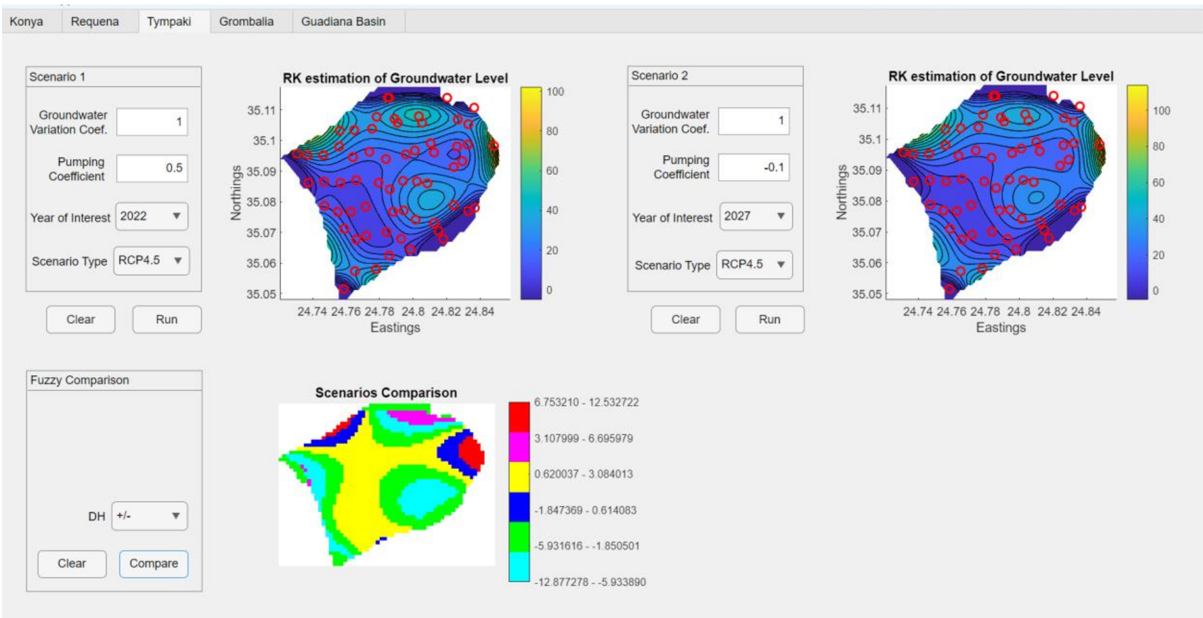

Figure 23. Tympaki study site-Groundwater Coeff.:1, Pumping Coeff.: -0.1, Year:2027, RCP:4.5, DH: +/-

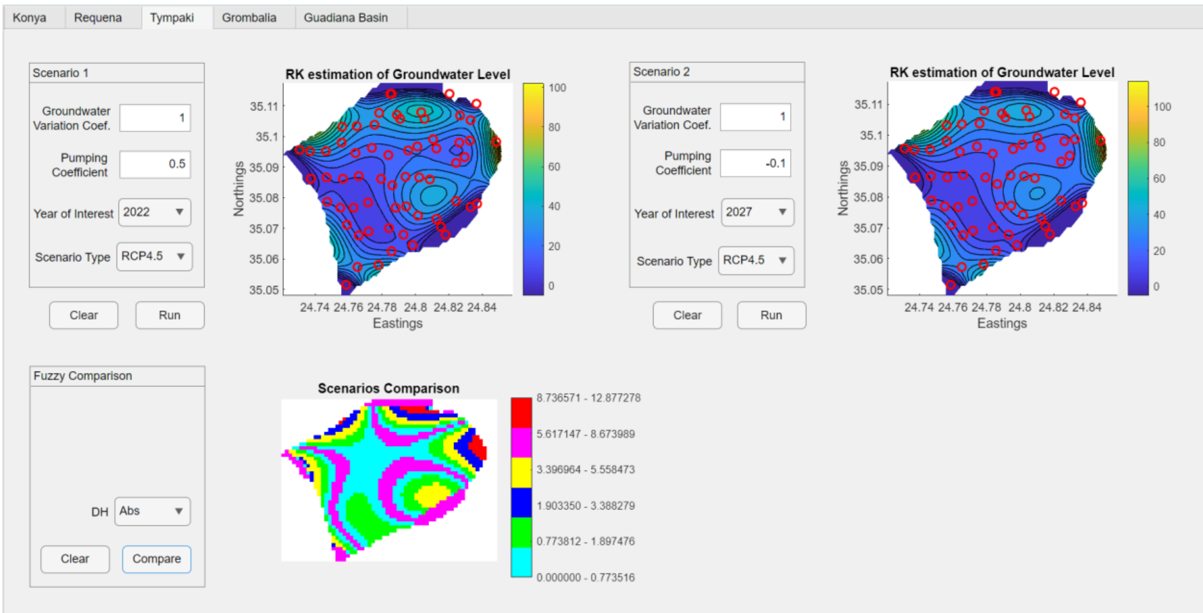

Figure 24. Tympaki study site-Groundwater Coeff.:1, Pumping Coeff.: -0.1, Year:2027, RCP:4.5, DH: Abs

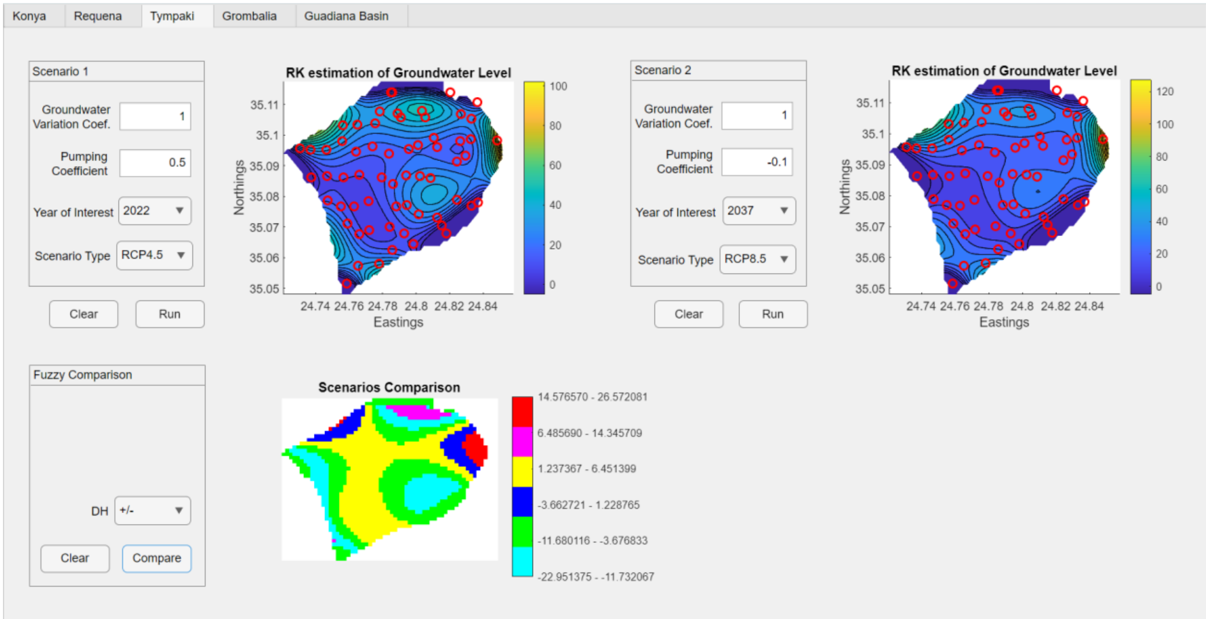

Figure 25. Tympaki study site-Groundwater Coeff.:1, Pumping Coeff.: -0.1, Year:2037, RCP:8.5, DH: +/-

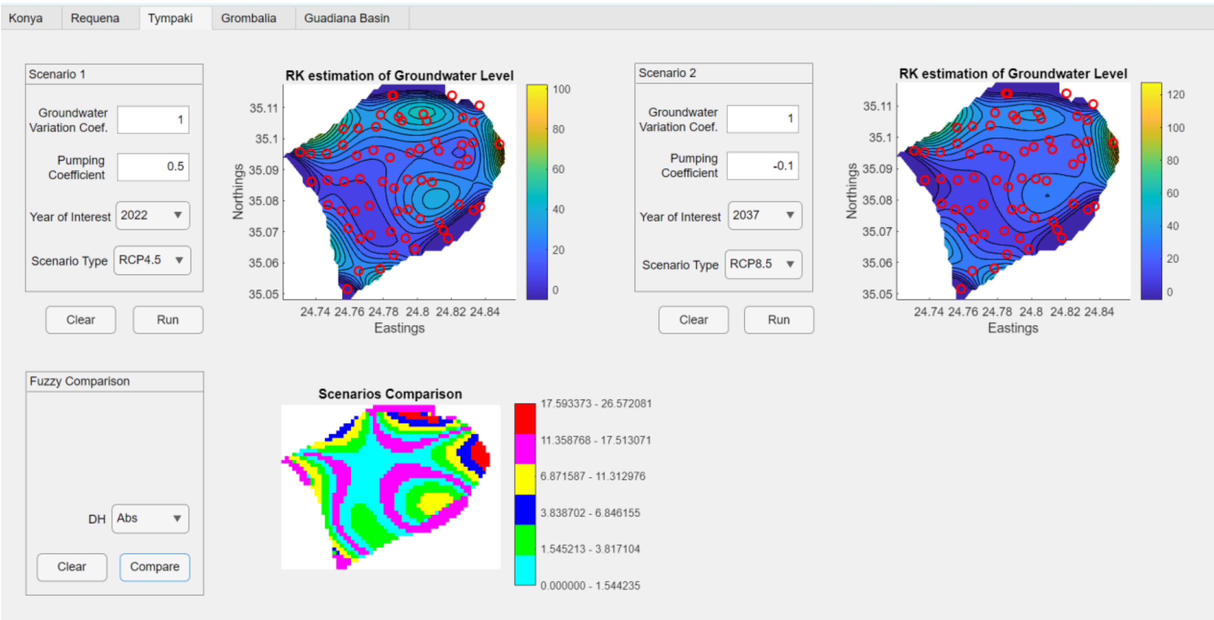

Figure 26. Tympaki study site-Groundwater Coeff.:1, Pumping Coeff.: -0.1, Year:2037, RCP:8.5, DH: Abs

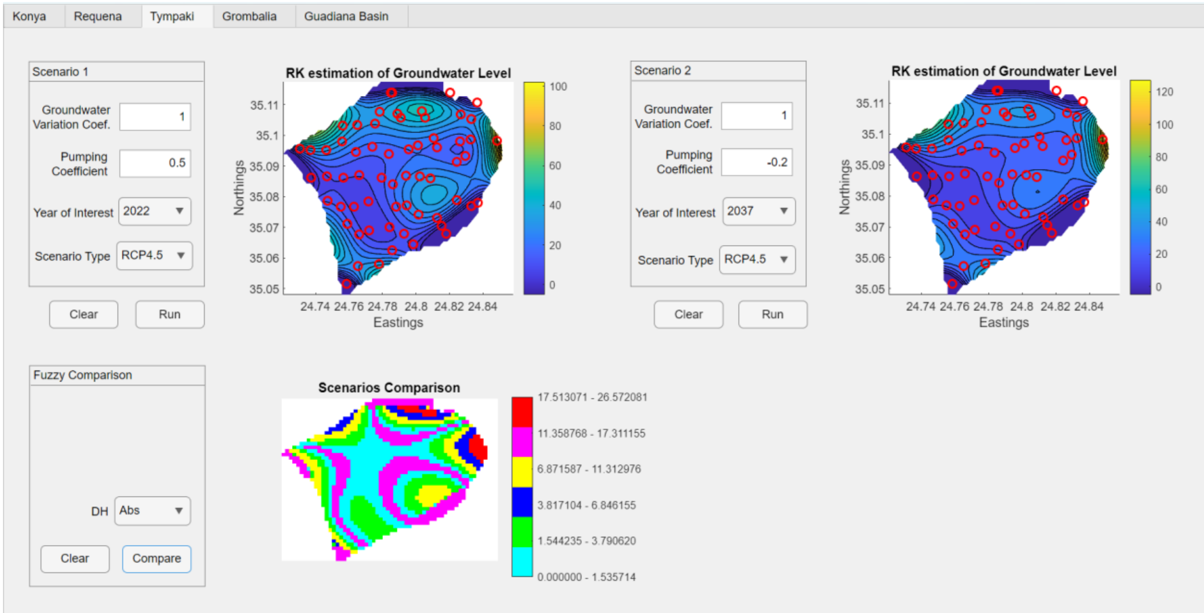

Figure 27. Tympaki study site-Groundwater Coeff.:1, Pumping Coeff.: -0.2, Year:2037, RCP:4.5, DH: Abs

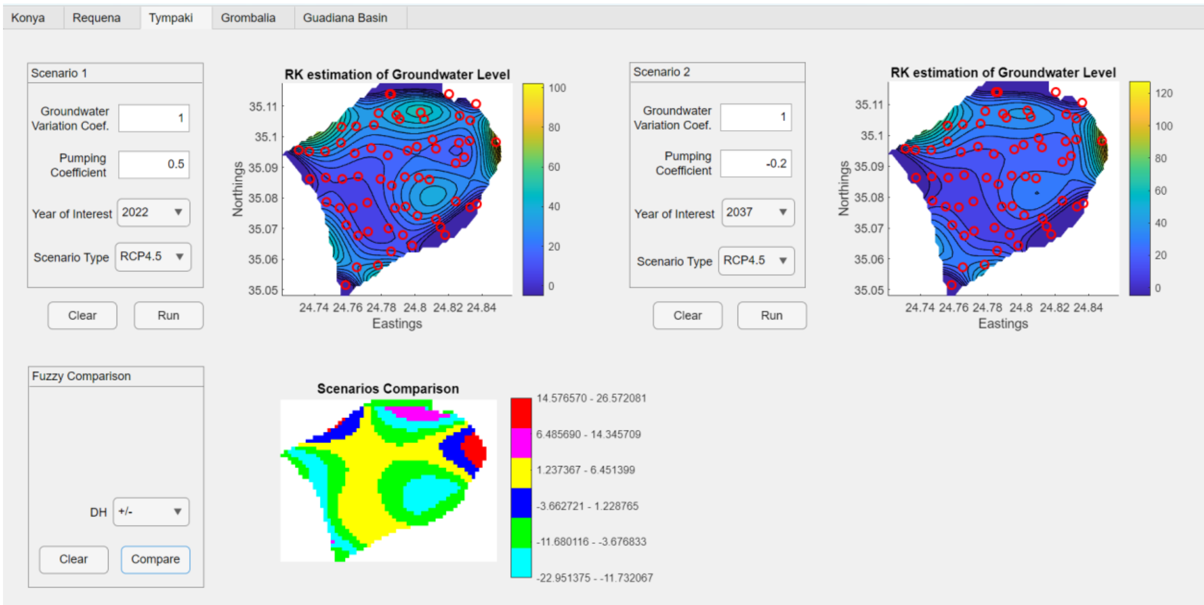

Figure 28. Tympaki study site-Groundwater Coeff.:1, Pumping Coeff.: -0.2, Year:2037, RCP:4.5, DH: +/-

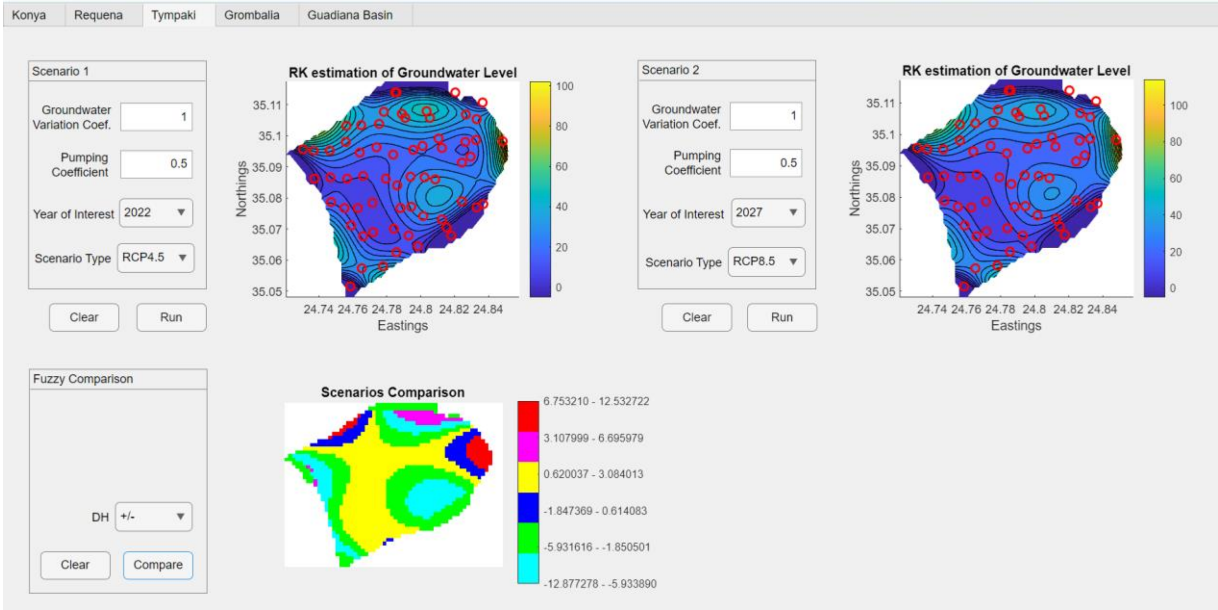

Figure 29. Tympaki study site-Groundwater Coeff.:1, Pumping Coeff.: 0.5, Year:2027, RCP:8.5, DH: +/-

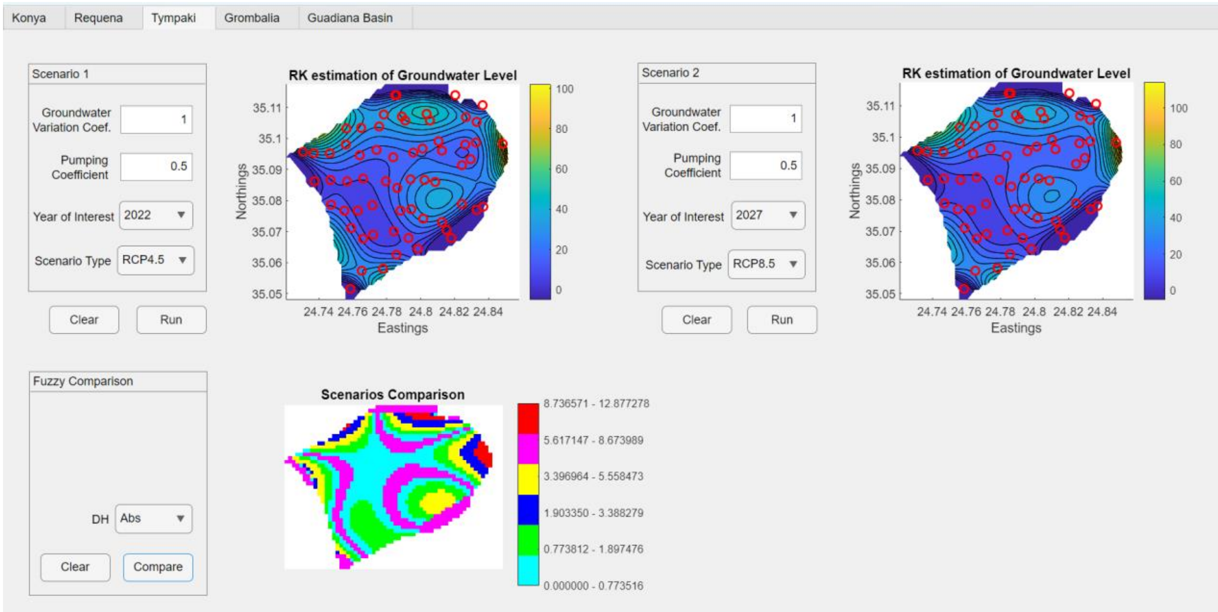

Figure 30. Tympaki study site-Groundwater Coeff.:1, Pumping Coeff.: 0.5, Year:2027, RCP:8.5, DH: Abs

3. Conclusions

The "Atlas of Groundwater Level Maps" stands as a transformative milestone in the area of sustainable groundwater management, offering a holistic approach to address the pressing challenges faced by the Mediterranean region. Through the fusion of Decision Support Systems (DSS) and fuzzy logic, this atlas empowers stakeholders with tools that bridge the gap between data complexity and actionable insights. In conclusion, this atlas is more than a collection of maps; it is a demonstration to our commitment to responsible stewardship. By leveraging the power of DSS, we not only interpret the complexities of groundwater systems but also provide a path toward a sustainable and resilient Mediterranean water future.

4. References

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