Dashboard Manual
2024

Water, Peace and Security (WPS) partnership

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Acronyms

ABM	Agent-Based Model
CLD	Causal Loop Diagram
CSO	Civil Society Organizations
IWRM	Integrated Water Resources Management
NGOs	Non-Governmental Organizations
RIBASIM	RIver BAsin SIMulation (Deltares Model)
SPI	Standard Precipitation Index
ToR	Terms of Reference
UN	United Nations
WEF	Water Energy Food
WFP	World Food Programme
WISO	Wetlands International Sahelian Office
WPS	Water, Peace and Security Partnership
WRI	World Resources Institute

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Disclaimer

The dashboard uses data to explore scenarios and estimate the impact of implementing certain measures on water security and displacement indicators. By using this information, you agree that Deltares and Water, Peace and Security partnership (WPS) are not liable for any decisions taken based on the data or conclusions presented.

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1 Introduction

To help mitigate conflicts over resources in Iraq, the Water Peace and Security programme is working with local stakeholders to develop a local analytical tool to assess the water resources situation and test future measures and scenarios. Local data is combined with global data to develop a water resources model and test interventions. Technical knowledge is thus integrated into a policy dashboard, an analysis and visualization tool via an interactive, easy-to-use platform. The aim is to enable stakeholders to jointly explore and visualize possible courses of action and their impact on selected indicators.

The process follows a participatory approach, and the dashboard attempts to incorporate the needs of future users, as emphasized during the workshops. Based on this input, Deltares developed several prototypes which were presented and discussed during the workshops with stakeholders (Sept. and Nov. 2022). Following the workshops, modifications were made to the tool by the Deltares team. This finalizes the development phase of the tool so that it can be tested by local stakeholders.

Two relevant issues that hindered the development of the dashboard were the uncertainty about who would be the target user of the dashboard and the engagement of local stakeholders (e.g. farmers). The latter provides useful input for the development of the human behaviour model that informs the dashboard.

For the further development of the dashboard, we would like to hear from users if and how this tool is being used, and whether the dashboard itself needs some modifications in terms of content or layout, to better meet their needs.

The purpose of this document is to summarise the decisions that have been taken on the scenarios and interventions to be included in the dashboard. The aim is to inform and guide users in their understanding and use of the tool. The document also aims to provide advice on how to use the dashboard, as well as exercises for getting to grips with it.

1.1 Objectives

The dashboard is an interactive platform that can be used as a tool for exploring and visualising different development and natural resources management scenarios and their potential impact on selected indicators, namely water security and displacement.

The main objective of the dashboard is to explicitly show the interlinkages between water and society to support discussions about future developments in the region.

1.2 Users

The following groups of people are seen as potential users:

- Political decision-makers and their senior policymakers at local and national levels who have recognised the importance of conflict-sensitive water allocation decisions, have the power to make these decisions and are willing to make them.
- Champions and participants in the process. They are people from different levels and roles in society, for example academics, who are able to influence local communities.
- The WPS local partners, with support from the WPS team, could use the dashboard in their own work in Iraq.

2 Dashboard manual

2.1 General information

The dashboard was developed using Microsoft Power BI software (free license). It was initially created offline but has been published on the web, allowing users to access it with just a web browser and an internet connection. No particular IT skills are required to use the dashboard.

The dashboard is interactive, featuring clickable buttons to change indicators, scenarios, and measures. Users can find additional information by clicking on the “information” icons.

The integrated data comes from numerical models, including hydrological and climate data, as well as an agent-based model that simulates human responses. The hydrological model covers aspects such as river flow simulation, water allocation, and dam management. The agent-based model simulates the simplified behaviour of different agents (actors) to assess the impact of scenarios and measures on water security and displacement risk.

2.2 Access

The dashboard can be accessed via this link OR open your web browser and copy this link in your browers.

https://app.powerbi.com/view?r=eyJrIjoiYjYxODg4ZjEtMTdlYy00NmMwLWE1MjgtN2U3ZWQwMzM5ZWVlIiwidCI6IjE1ZjNmZTBlLWQ3MTItNDk4MS1iYzdjLWZlOTQ5YWYyMTViYiIsImMiOjh9&pageName=9fb137f23a9e8f279ecb.

2.3 Functions

2.3.1 Page: Indicators

The dashboard is structured into two distinct pages, each focusing on critical aspects of regional analysis. The **Indicators** page provides a comprehensive overview of various scenarios and measures at the governorate level for Al Basrah, Dhi Qar, Maysan, and Wasit. This page highlights key indicators such as water security risk and displacement risk, presenting data for different combinations of scenarios and measures. By visualizing these risks, the dashboard enables stakeholders to assess the potential impacts of various strategies and make informed decisions to mitigate these risks effectively.

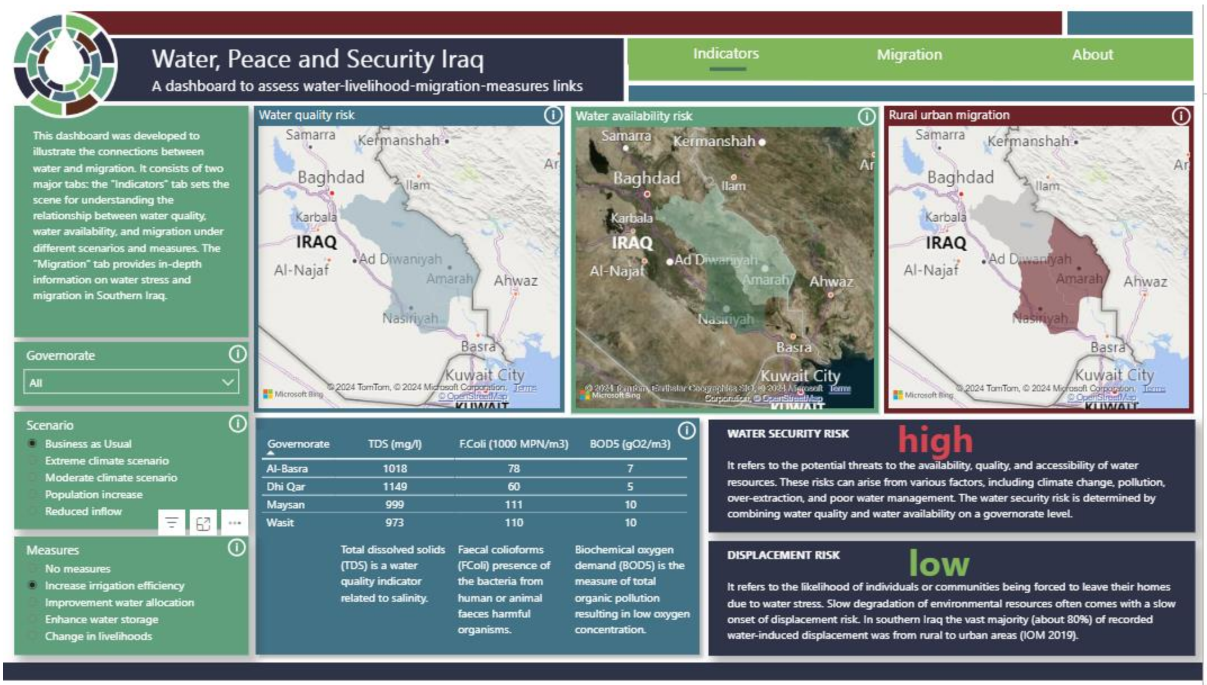

Figure 1: Dashboard Indicators Page

The following figure shows how the selection is processed to a case composition showing information in maps and indicators.

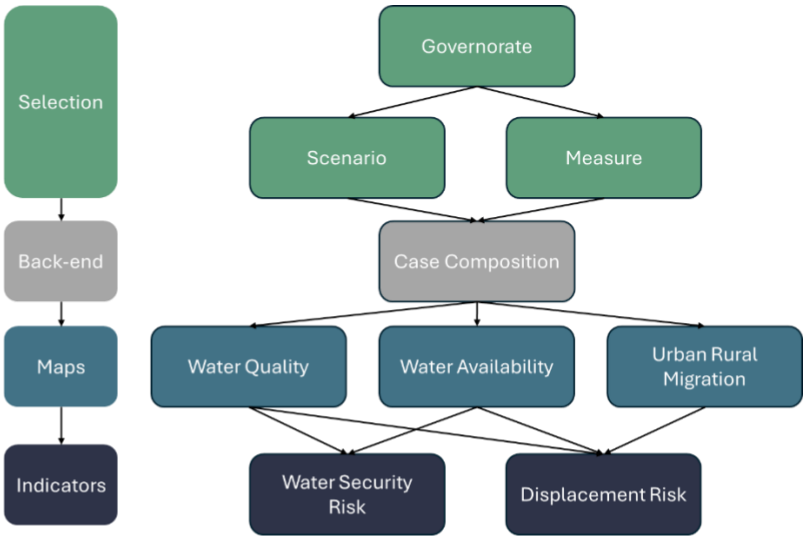

Figure 2: Case Composition and Indicators

2.3.2 Page: Migration

The **Migration** page delves into the dynamics of water stress and internal displacement, focusing on the governorate of origin. This page illustrates the levels of water stress experienced in different regions and tracks the patterns of internal displacement. By correlating water stress with displacement trends, the dashboard provides valuable insights into the root causes of migration and helps in planning interventions to address these challenges.

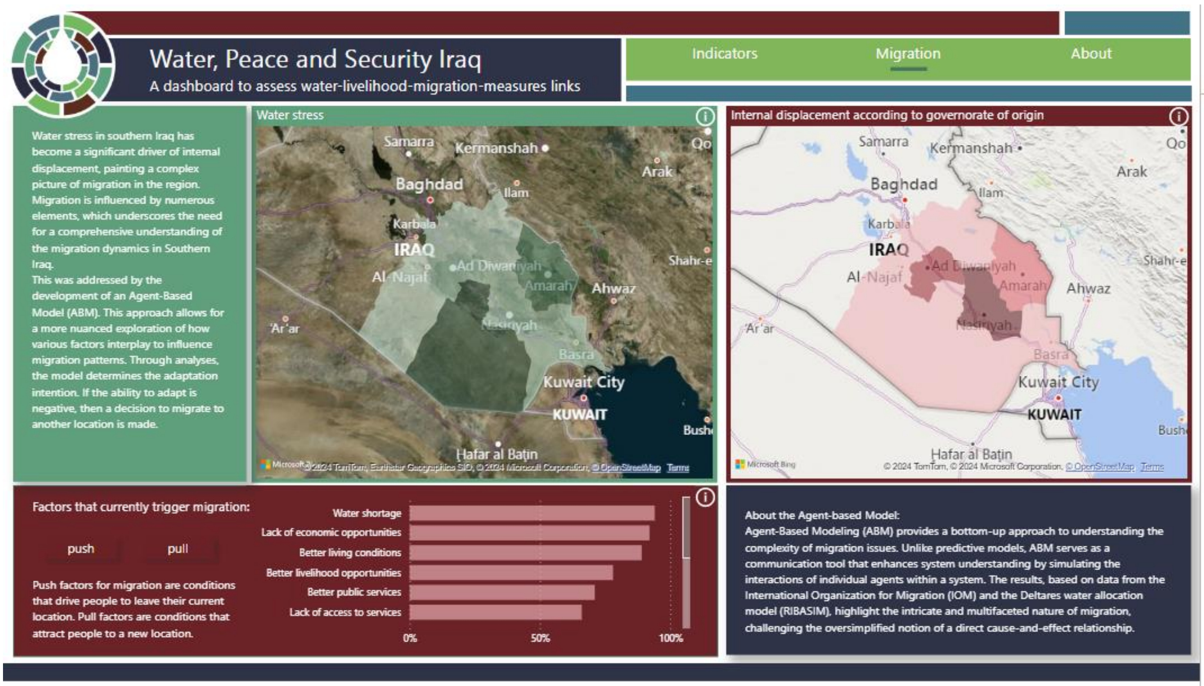

Figure 3: Dashboard Migration Page

2.3.3 Page: About

The about page provides general information on the WPS project and activities in Iraq as well as the main data sources that were used to create this dashboard.

2.4 Customizing your view

The dashboard allows users to select different scenarios and measures, or a combination of both, and see how the can impact selected indicators. The main dashboard components re indicated in **Error! Reference source not found.**.

2.4.1 Governorate

The dashboard displays information from the southern districts in Iraq. The districts available for selection are Al Basra, Dhi Qar, Maysan and Wasit.

2.4.2 Scenarios

The scenarios used in this project were both climate scenarios and socio-economic scenarios. The scenario "Business as usual" is a continuation of current climatic change and applied measures. The scenarios "Extreme climate scenario" and "Moderate climate scenario" are both climate change scenarios. The scenario Population increase assumes an increase in population of 50%. The scenario Reduced inflow assumes a 20% reduction of transboundary inflow from the upstream countries.

2.4.3 Measures

"No measures" indicates that no measures are implemented. Improvement of water allocation considers a reduction in potable water supply losses from 50% to 20%. Increase irrigation efficiency refers to a 30% increased irrigation efficiency. Enhance water storage refers to a 30% increase in the volume that can be stored in the basin thanks to the reservoirs of Ataturk and Mosule. Change in livelihoods considers a decrease in the irrigation demand of 30% in the months of June-July-August due to a change in livelihoods.

2.4.4 Indicators

- Primary indicators
    - Water security risk
    - Displacement risk
- Secondary indicators

- Rural-urban migration (n. of people)
- Water quantity MCM/year
- Water quality: Total dissolved solids TDS (mg/L)
- Water quality: Faecal coliforms FColi (MPN/m^3)
- Water quality: Biochemical oxygen demand BOD5 (gO_2/m^3)

While secondary indicators visualise quantified data, based on literature or as a result of models, primary indicators visualise risks. The thresholds for both water security risks and displacement risks are explained as follows.

2.4.5 Water Security Risk

Water security risk refers to the potential threats to the availability, quality, and accessibility of water resources. These risks can arise from various factors, including climate change, pollution, over-extraction, and poor water management. The water security risk in this project is determined by combining water quality and water availability on a governorate level.

It depends on the indicators of water quality and water quantity. Water quality is presented in relation to Total dissolved solids (TDS), Faecal coliforms (FColi) and Biochemical oxygen demand (BOD5), based on the results from the DWAQ model from IOM (2020).

Results from the model only partially cover the data needed to display the desired information in the dashboard. The available data from IOM (2020) is detailed in table

Table 1.

When information for a certain indicator is not available, the governorate will be displayed in grey colour.

Table 1. Overview of the indicators from IOM (2020) that were used in the development of the dashboard and how. The table also includes the assumptions indicated by IOM. For all indicators, the value used corresponds to the average value between 1998-2018 for the indicators of Total dissolved solids, Faecal coliforms, and Biochemical oxygen demand.

Information available (IOM, 2020)	Assumption	Use in the dashboard
Base case	-	Base case
Increase of irrigation efficiency in 30%	This scenario assumes a drastic increase in efficiency, by 30 percentage points, meaning that efficiency goes from the current 30% to a hypothetical 60% in the future.	Measure 1 – increase irrigation efficiency
Climate change GFDL	Changes in precipitation and evaporation according to the GFDL-ESM2 model and the RCP 8.5 climate change scenario for the period 2040–2060. The impact of climate change, which affects both water availability and the demand for irrigation water when precipitation volume and temperatures change, is investigated according to standard models of climate change prediction. The GFDL-ESM2M Global Circulation Model estimates an increase in temperature between 2020 and 2050 of 1 degree Celsius, and annual precipitation fluctuations between 200 and 500 mm, with some higher peaks.	Scenario 2 - moderate climate scenario
Climate change HadGEM2	Changes in precipitation and evaporation according to the HadGEM2-ES model and the RCP 8.5 climate change scenario for the period 2040–2060. The impact of climate change, which affects both water availability and the demand for irrigation water when precipitation volume and temperatures change, is investigated according to standard models of climate change prediction.	Scenario 3 - extreme climate scenario

	The HadGEM2-ES Global Circulation Model estimates an increase in temperature between 2020 and 2050 of 1.5 degrees Celsius, and annual precipitation fluctuations between 250 and 400 mm, with some higher peaks.	
Decrease of inflows from upstream countries with 20%	A 20% increase or decrease is assumed in changes in inflows from upstream countries. Changes in inflow may be the result of climate change or upstream water regulation and abstraction, or of a combination of both	Scenario 1 - Reduced inflow
Increase of irrigation demand with 30%	Irrigated agriculture uses most water of the Tigris-Euphrates catchment. In this scenario, it is assumed that all irrigated areas in Iraq, Turkey, Syria and Iran will increase by 30%	Scenario 4 - Population increase

Data from IOM (2020) covers only the base case, scenarios 1 to 4 and measure 1, but not any combination of scenarios and measures.

To estimate the water security risk, the thresholds for water quality and water quantity were analysed. For water quality, the thresholds for each indicator are:

- Total dissolved solids (TDS)
    - Fair drinking water quality (600–900 mg/L)
    - Poor drinking water quality (900–1200 mg/L)
    - Unacceptable drinking water quality (1200–2000 mg/L)
    - Harmful for agriculture (2000–4000 mg/L)
- Faecal colioforms (FColi)
    - Drinking water quality (<10000 MPN/m^3)
    - Excellent bathing usage quality (10000-5000000 MPN/m^3)
- Biochemical oxygen demand (BOD5)
    - Good quality (<3 gO_2/m^3)
    - Acceptable (3-10 gO_2/m^3)
    - Poor (>10 gO_2/m^3)

Water quality indicators and their thresholds are defined based on the World Health Organization guidelines (WHO, 2017). For the estimation of the water quality risk, if any individual indicator was below the acceptable threshold for human consumption, then the water quality risk was medium. Likewise, if any indicator was below the threshold for use in irrigation, then the water quality risk was high. More information about the individual indicators and thresholds can be found in the Dashboard Manual.

For water quantity, the thresholds were estimated based on percentages of the highest water availability in terms of MCM per year across all scenarios and measures. The classification is as follows:

- High risk: between 38,328 and 57,491 MCM/year
- Medium risk: between 19,164 and 38,327 MCM/year
- Low risk: between 0 and 19,163 MCM/year

2.4.6 Displacement risk

Displacement risk refers to the likelihood of individuals or communities being forced to leave their homes due to water stress. Slow degradation of environmental resources often comes with a slow onset of displacement risk. In southern Iraq the vast majority (about 80%) of recorded water-induced displacement was from rural to urban areas (IOM 2019).

2.4.7 Migration

Water stress in southern Iraq has become a significant driver of internal displacement, painting a complex picture of migration in the region. The identification of various push and pull factors reveals that migration is not a straightforward process but rather a multifaceted one influenced by numerous elements. This underscores the need for a comprehensive understanding of the migration dynamics in southern Iraq, which was addressed by the development of an Agent-based Modeling (ABM) in WPS. Unlike predictive models, ABM serves as a communication tool that enhances system understanding by simulating the interactions of individual agents within a system. This approach allows for a more nuanced exploration of how various factors interplay to influence migration patterns.

The model uses input from a water allocation model (RIBASIM) and analyses the risk and adaptation appraisal to determine the adaptation intention in every timestep. If the ability to adapt is negative, then a decision to migrate to another location is made.

A study by the Internal Displacement Monitoring Centre (IDMC) investigated internal displacement associated with slow-onset environmental change. In interviews, several push factors for internal displacement were mentioned. Findings are based on quantitative and qualitative data collected between June and July 2019 among both displaced and non-displaced people from Al-Basra, Missan, and Dhi Qar governorates. Pull factors for migration were also identified.

Push factors for migration are conditions that drive people to leave their current location, a study by the Internal Displacement Monitoring Centre (IDMC) found that water shortage and lack of economic opportunities are two major push factors in the southern governorates of Iraq. Pull factors are conditions that attract people to a new location. In the case of Southern Iraq better living conditions and livelihood opportunities were identified in the same study (Guiu, R. 2020).

It is often assumed that there is a straightforward, linear relationship between the lack of resources and migration. However, this is not the case. ABM provides a bottom-up approach to understanding the complexity of migration issues. The results, based on data from the International Organization for Migration (IOM) and the Deltares water allocation model, highlight the intricate and multifaceted nature of migration, challenging the oversimplified notion of a direct cause-and-effect relationship.

3 Data and models

3.1 Hydrological model

A hydrological model helps us to quantify the relationship between the factors involved in the water system. For Iraq, we used a water allocation model (RIBASIM). It uses flows as input data and calculates river regulation by dams and weirs, and allocation to various water users, based on information on the presence of infrastructure, population, and irrigated areas. This gives us an overview of how water is available to different water users in different parts of the basin and can be used to assess how these evolve in the light of possible future developments, such as climate change, population, growth, etc.

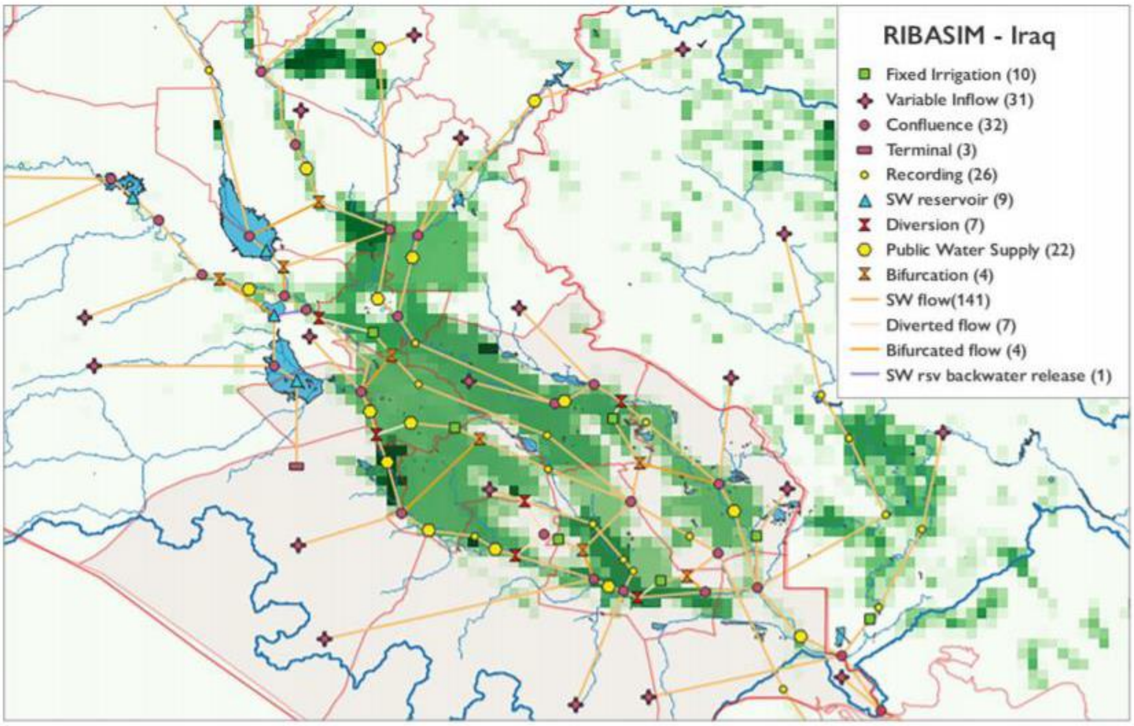

Figure 4: RIBASIM schematisation of Tigris-Euphrates with Global Irrigation Data

RIBASIM is a software tool that visualizes water allocation on the sub-catchment scale. A node network is created based on the water users per sub-catchment and a water balance is created from up- to downstream. The results of the model are organized and presented per node. To translate them into administrative units, we need to assign the results of certain nodes, or weighted combinations of nodes to an administrative unit, to be able to present the results on governorate level.

- Scenarios
  - A series of monthly flows from 1990 – 2018 was used for the model.
  - A reference year normally refers to a certain situation in the basin, and this is something we have to decide upon. This needs to be decided together with stakeholders.
- Measures
  - Increase irrigation efficiency: model runs with increased irrigation efficiency were made already and the results are available.
  - Water allocation improvement is modelled as a change in the distribution % per sector, but it has not been validated by stakeholders.
  - Enhance water storage (e.g. new dams). It considers increasing water storage thanks to dams. The Ilisu dam is included in the model as “inactive”, but it can be set as “active”.

3.2 Water quality model

A water quality model was explored under this project, using DWAQ. However, data was not sufficient at this stage to further develop the model and integrate its results in the dashboard. Therefore, the water quality data needed for the development of the dashboard was obtained from literature (IOM, 2020).

- Total dissolved solids TDS mgTDS/L
- Faecal coliforms FColi MPN/m^3
- Biochemical oxygen demand BOD5 gO_2/m^3

Table 2. Average values of water quality indicators. Based on table 5 - Summary of Water Quality Model Results (IOM, 2020)

Governorate	TDS (mg/l)	F.Coli (MPN/m^3)	BOD5 (gO$_2$/m^3)
Al-Basra	1148	93362	9
Dhi Qar	1985	113676	10
Maysan	954	98349	9
Wasit	875	89874	8

3.3 Agent-based model

Human behaviour is an important component of the link between natural resources and safety, Human behaviour encompasses "human responses to changes in the environment and to the actions of other actors, taking into account institutional, political, historical and other factors".

Agent-based modelling is a tool for simulating complex systems made up of different interacting "agents". Agents adapt and evolve. The result of the agents' behaviour leads to interactions and certain trends may emerge. For example, migration from a certain area when water availability falls below a certain threshold. An ABM can simulate trends in the responses of various groups of actors to changes in their environment (physical, institutional, social). Thanks to this simulation, the ABM makes it possible to explore different scenarios and measures for situations that cannot be tested in reality. See figure x for a conceptual ABM of the links between water and displacement.

We use agent-based modelling as a research method to formalise, test and adapt our understanding of the behaviour of actors in specific regions as they respond to changes in resource availability, regulation (e.g. access to resources), demography, etc. Agent-based modelling helps to fill in the links to the right-hand side of the causal loop diagram, related to livelihood and conflict.

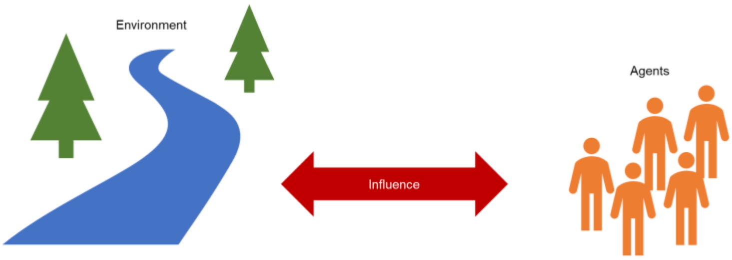

Figure 5: Agent-based Model (ABM)

3.3.1 Investigation of Human Responses

To gain a deeper understanding of human responses to migration, we analyzed information from online literature, including academic peer-reviewed journal articles and reports from various organizations active in southern Iraq. To further comprehend the situation in Iraq, we conducted interviews with experts to understand the context in the southern governorates. Additionally, we gathered global information to better understand general responses to water scarcity.

3.3.2 Conceptualization of the Migration Decision

To model the environmental migration phenomena in Southern Iraq, this project employs an Agent-Based Model (ABM) to conceptualize and quantify migration decisions. A well-designed ABM for this region will enhance academic understanding of water-related migration decision-making pathways within the Iraqi context. This, in turn, can inform the creation of effective, targeted policies and the exploration of intervention scenarios. For instance, the spatial component of an ABM can help identify areas likely to experience increased social tensions due to rapid influxes of displaced people. Additionally, the dynamics of migration decisions are under-researched, with limited concrete data on the motivations or hesitations to migrate. This project investigates the migration decision-making process and lays the foundation for a more complex ABM for the southern governorates, which can be expanded in the future to include other human responses and potential conflict analysis.

3.3.3 Approach

After investigating how the adaptation and migration decision-making process is represented and quantified in other ABMs, this research included the development of a Water-Related Migration Model for Southern Iraq for the governorates of Al-Basra, Dhi Qar, and Maysan. The ABM was coded in NetLogo, a coding software designed for the implementation of ABMs (Wilensky, 1999). The model simulates the migration of city-dwelling and farming households due to the worsening of surface water availability and quality. This process focuses on designing a valid model that fully captures key components and interactions within complex systems and interpreting results in a meaningful manner. The model runs from 2005, which coincides with the establishment of a new Iraqi government after the Saddam Hussein regime. The model imports water data every month thereafter, continuing through 2018, which is the last year data is provided from the hydrologic model RIBASIM. This approach attempts to convert theories of psychology and real-world data into mathematical representation of the decision-making process in simple loops, as shown in Figure 1.

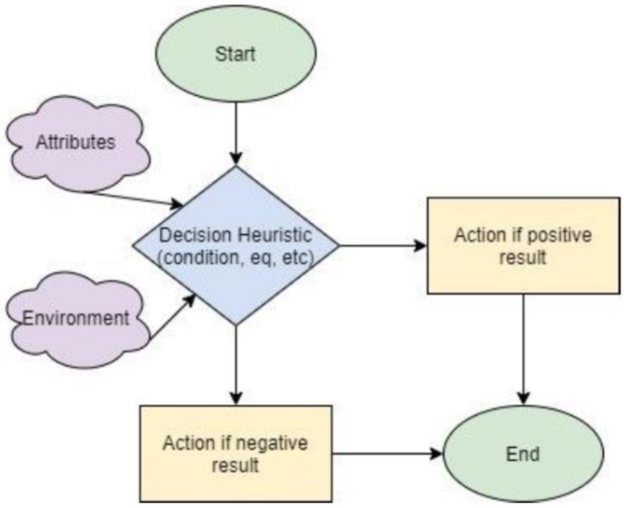

Figure 6: Basic operation of a singular decision and action in an ABM (Knox, 2021)

3.3.4 Overview of Model

Figure 2 illustrates the basic organization developed ABM. The green box represents the scope of the model and the yellow circle represents the cognitive processing to make the migration decision. The migration decision is based on a number of components: risk appraisal, adaptation appraisal, and adaptation intention. Each aspect of the model will be elaborated on in later sections, with additional information on how WRMMSI quantifies and conceptualizes the migration decision-making process in Section 3. Key assumptions used to build the model are included in Appendix 5.

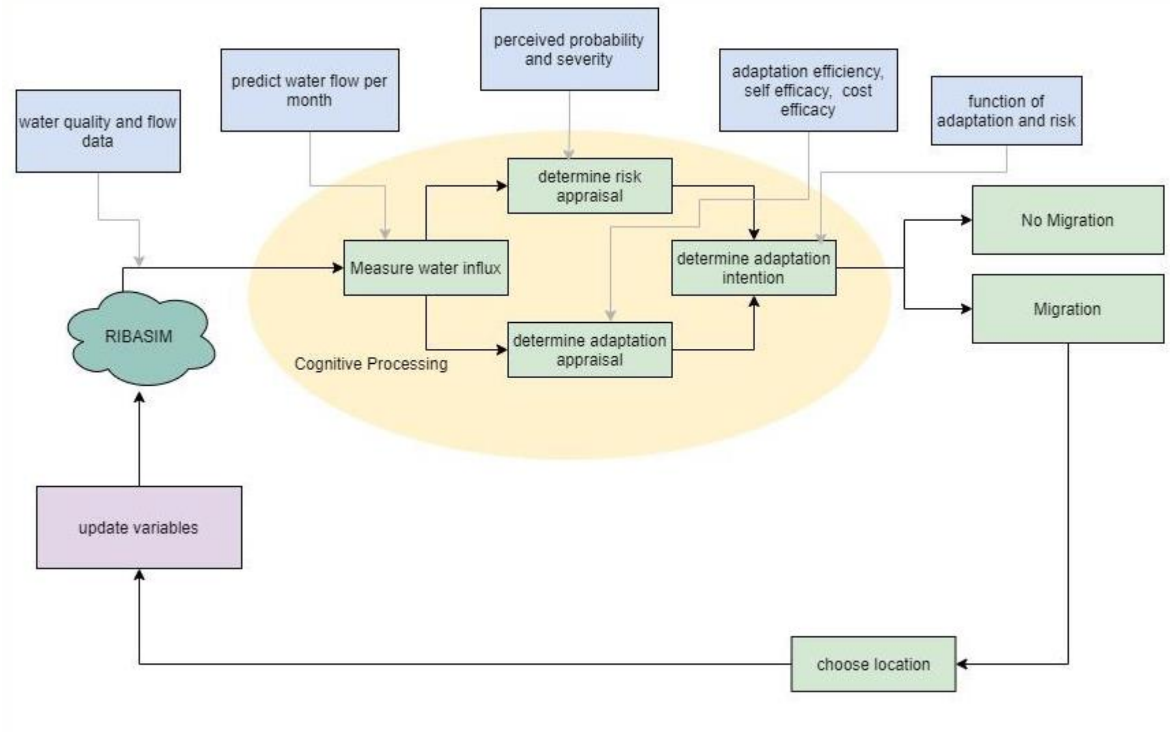

Figure 7. Model Flow ABM (Knox, 2021)

4 Dashboard use

The dashboard has been designed to bridge the gap between the distinct disciplines of water resources management and migration studies. Recognizing that these fields often operate in silos, we aimed to create a tool that integrates data and insights from both areas. By doing so, we provide a comprehensive view that highlights the intricate interconnections between water stress and migration patterns. This approach ensures that both water experts and migration experts can easily navigate and interpret the data, fostering a deeper understanding of how these realities are intertwined. The dashboard serves as a platform for cross-disciplinary dialogue, enabling stakeholders from both fields to collaborate more effectively and develop holistic strategies to address the complex challenges at the intersection of water security and human mobility.

When interpreting the data, remember that it is derived from both models (Deltares) and monitoring data from the International Organization for Migration (IOM). A major outcome of the project, and a key insight from the dashboard, is that the relationship between water stress and migration is complex and non-linear. Therefore, avoid oversimplifying the data to ensure accurate assumptions and conclusions. Recognize that multiple factors influence migration patterns, and a nuanced approach is essential for responsible data interpretation.

5 References

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