# Mainstreaming Climate Change Adaptation into Water Development Plan Case of Morocco


**Laila Oualkacha, Laila Stour, and Ali Agoumi**

**Abstract** Mainstreaming climate change adaptation into development plans requires sustained improvement of the political, economic, social, technical, environmental, and legal aspects. International organizations have developed processes to support developing countries in mainstreaming climate risks into water development plans. However, the implementation of this process remains a significant challenge, while many adaptation projects are generally managed outside the existing processes of planning and development. Decision-makers and critical players in the ground agree that there is a deficiency in "how to operationalize the mainstreaming process in the water sector?" This article aims to answer the above question by exploring a structured approach that decision-makers can use to operationalize mainstreaming climate change adaptation into the water development plan at the local level. This approach considers a completed strategic analysis of political, economic, social, technical, environmental, and legal aspects. The results of this approach have generated the proposed theoretical tool designed to reflect the dynamism of climate change phenomena through its seven iterative steps, which permit to identify most vulnerable units, climate change impacts, prioritized adaptation actions, mechanisms to access climate funds, processes for implementation, monitoring and evaluation. The proposed approach has been tested in two Moroccan river basins: the Loukkos and the Tensift RBs. Similar river basins of Algeria and Tunisia will also be tested using the same processes.

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## 1 Introduction

Water is a crucial resource for economic growth and development in Morocco. It contributes widely to the socio-economic balance and the Gross Domestic Product. However, water is endangered by Climate Change (CC), and Morocco seems to be one of the most vulnerable countries globally concerning water scarcity, according to the fifth report of the Intergovernmental Panel on Climate Change (IPCC 2014).

Moroccan climate data depict a noticeable warming trend over the past 40 years and a net increase in the frequency of droughts and floods within the country (Moujahid et al. 2015). Future climate trends in Morocco include rising temperatures of 1–1.5 °C by 2050 and a decrease in average precipitation by 10–20% across the country by 2100 (ME 2016).

In this challenging context, Morocco has adopted some plans and strategies, such as National Strategy against CC and National Plan against CC. Despite all undertaken efforts, implementation of mainstreaming CC adaptation into development plans remains a significant challenge at national and local levels. The national strategies have highlighted some of these adaptation measures; however, these measures are usually managed outside the existing planning process, which is mainly the case of the water sector.

Mainstreaming CC adaptation into development plans' "mainstreaming process" is defined by the United Nations Development Program (UNDP) as an iterative process to integrate CC aspects and adaptation into policy decisions and budgeting at national and local levels (UNDP 2011). The mainstreaming process requires coordination among multiple stakeholders and institutions, making the journey from a plan on paper to action on the ground slow (Mogelgaard et al. 2018).

Despite growing political attention and tools to support mainstreaming, an implementation gap persists (Mogelgaard et al. 2018). Furthermore, international organizations (UNDP, the United States Agency for Integrated Development, and the Deutsche Gesellschaft fur international cooperation (GIZ)) have developed processes to support developing countries (DC) to operationalize mainstreaming process. However, these processes provide only general guidance, and efforts have been slow to translate mainstreaming into concrete actions and programs at national and local levels (Mogelgaard et al. 2018).

Implementation of the mainstreaming process depends on the synergy between sectors at national and local levels (Eisenack et al. 2014). It also requires sustainable strategic coordination, explaining the challenges and the complexity of implementing this process (Waters et al. 2014). Thus, operationalizing the mainstreaming process remains a significant challenge (Mogelgaard et al. 2018), and the key question is "how to operationalize the mainstreaming process"?

Considering the gaps emphasized previously regarding mainstreaming process implementation, this article aims to present an approach that permits to operationalize "mainstreaming process" at the local level within the water sector: 'the Tool for Mainstreaming CC (TMCC). The TMCC is developed using qualitative and quantitative approaches. It is composed of seven iterative steps, harmonized in

a coherent manner, which generates a practical and comprehensive approach that supports decision-makers to operationalize the mainstreaming process and enhance the River Basin (RB) resilience.

The TMCC's findings help identify the most vulnerable units, CC biophysical and socio-economic impacts, and prioritized adaptation actions, funding and implementation processes. These results permit to improve water resources (WR) management and planning, including climate risks. The TMCC has been tested in two Moroccan RBs: the Loukkos and the Tensift RBs. Similar RBs of Algeria and Tunisia will also be tested using the same processes.

## 2 Methodology and Tool

### *2.1 Combination of Qualitative and Quantitative Approaches*

Mainstreaming process is a complicated procedure to address through a combination of qualitative and quantitative approaches (Benjamin et al. 2017). This combination of methods has been described as the best approach to address CC adaptation issues (Harrison et al. 2013). Thus, selecting this method to conduct the research.

The qualitative approach is used to identify the most vulnerable units, CC impacts and actions for adaptation, while the quantitative approach is used to develop scores and evaluation criteria.

### *2.2 Adopted Strategy*

The strategy adopted to design the TMCC is interactive; indeed, the TMCC provides guidelines to decision-makers through a collection of questions that allow to create resonance regarding CC mainstreaming process and identify barriers that inhibit the implementation of this process.

The answers to each question include strategic options developed considering several dimensions: efficiency, equity, feasibility and acceptability by the stakeholders within the water sector. Based on the suggested answers, decision-makers can choose the most suitable option that fits the context of their organization.

### *2.3 Design of the TMCC's Steps*

Figure 1 presents the TMCC's steps: preparation, vulnerability analysis, adaptation actions, integration of the relevant actions into the Integrated WR Development Plan (IWRDP), funding, implementation and monitoring processes. The 7 iterative steps

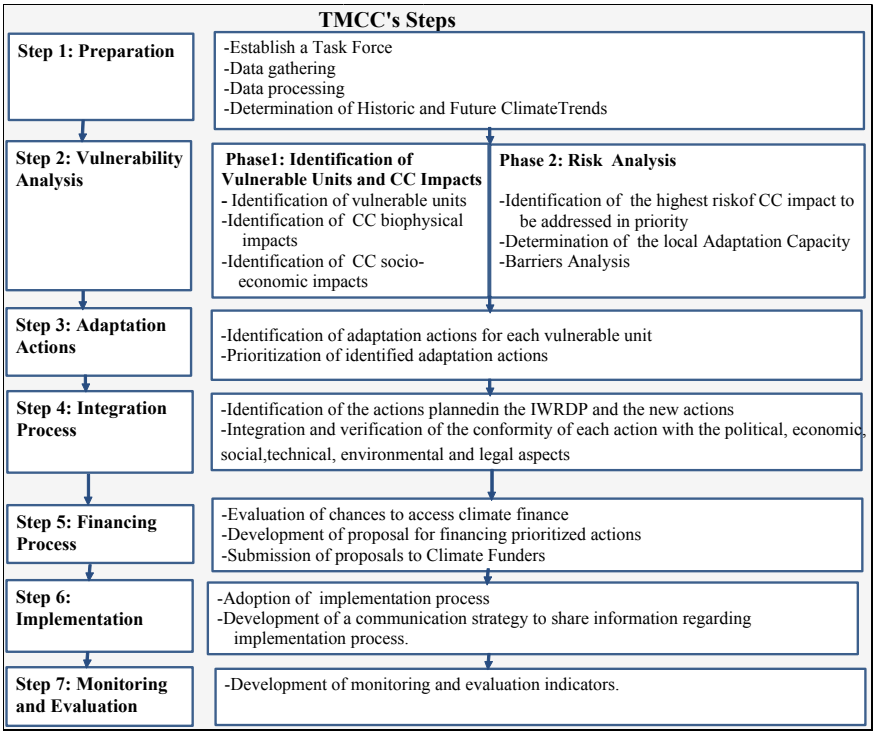


**Fig. 1** The TMCC's steps design

of the TMCC are harmonized in a coherent manner, where each step is an essential part in the chain of actions within the methodology; the output of one step is the input for the following step.

### Step 1 of the TMCC: Preparation

The TMCC suggests a participatory approach that engages different stockholders. Therefore during the first step, the decision-maker can establish a Task Force (TF) to monitor and coordinate mainstreaming process implementation. Step 1 involves building CC knowledge within the RB. It consists of gathering and analyzing CC data and determining historical and future climate trends. The climate data analysis requires the combination of CC physical concepts (temperature and rainfall) that can affect all aspects of planning and inhibit CC mainstreaming process implementation (Nouri and Costa 2017).

The combinations of CC physical factors have permitted to identify four situations: (i) Situation S1: decreased rainfall and increased temperature. (ii) Situation S2: decreased rainfall and decreased temperature. (iii) Situation S3: increased rainfall and increased temperature and (iv) Situation S4: increased rainfall and decreased temperature.

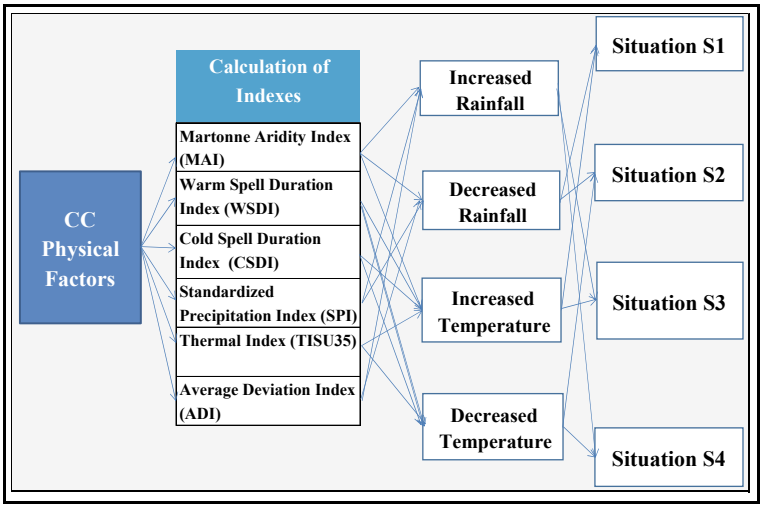


**Fig. 2** The design of the TMCC's step 1

To determine how CC physical concept can influence historical and future climate trends, the TMCC suggests the calculation of six indexes: (a) Martonne Aridity Index; (b) Warm Spell Duration Index; (c) Cold Spell Duration Index; (d) Standardized Precipitation Index; (e) Thermal Index; (f) Average Deviation Index.

Figure 2 presents the design of TMCC's Step 1. It shows that the six proposed indexes' calculation allows determining historical and future climate trends (S1, S2, S3 or S4) within the RB.

### Step 2 of the TMCC: Vulnerability Analysis

Based on the results of step 1, the TMCC suggests an approach to analyze the RB's vulnerability. Step 2 includes two phases: (i) Phase 1: identification of CC vulnerable units and impacts and (ii) Phase 2: risk analysis.

### Step 2–Phase1: Identification of Vulnerable Units and CC Impacts

An analysis of policy, economic, social, technical, environmental and legal (PESTEL) aspects has been undertaken to identify the most vulnerable units and CC impacts within the water sector. The results of this analysis support in identifying six (6) potential vulnerable units: (a) water supply; (b) water demand; (c) water quality; (d) territory, people and economic activities; (e) coastal zone and (f) water governance. To guide the decision-makers, the TMCC offers an inventory of potential CC biophysical and socio-economic impacts for each vulnerable unit. Indeed 55 CC impacts have been identified, including 25 biophysical impacts and 30 socio-economic impacts.

The results of step 2–phase1 allow the user to identify vulnerable units and CC expected biophysical and socio-economic impacts.

**Step 2–Phase 2: Vulnerability Analysis**

Local communities are vulnerable to CC if there is a probability of negative consequences that exceeds the intrinsic capacity of the community to adapt to CC (Williamson et al. 2014). Exposure, sensitivity and adaptive capacity are three common elements in most definitions of CC vulnerability (Williamson et al. 2014). Therefore, this second phase of step 2 will include three sub-phases related to these elements.

**Step 2, Phase 2, Sub-Phase 2.1**: The sub-phase 2.1 aims to identify the most significant risk of CC effects that should be addressed as a priority. Therefore, the first task is to assess the degree of exposure and the vulnerable units' sensitivity within the RB.

The TMCC considers the impact of the adverse effects of CC as the combined effect of the degree of exposure and sensitivity of vulnerable units within the RB. The importance of CC's impact on negative outcomes is evaluated through ranking scores from 1 to 5 (1 = very low and 5 = very high). A score of 1 means that the importance of CC's negative effects on vulnerable units is not very important. A score of 5 means that the significance of negative effects is expected to be very high.

The characterization of vulnerability includes the CC future uncertainty (Gleeson and Coll 2011). Therefore, the CC impacts are further evaluated through a risk analysis based on their probability of occurrence in the future. The TMCC has adopted five probability criteria rated from 1 to 5 for the 2050 horizon (1 = very low and 5 = very high). A probability of 1 signifies that the occurrence of the negative effect is not very likely. A probability of 5 means that this occurrence is considered to be very high.

After evaluating the importance of CC negative effects and their probability of occurrence in the future, climate risk is calculated by the following equation:

$$R = P * I$$

R is the climate risk;
P is the probability of future occurrence of CC negative effects;
I refers to the importance of negative effects of CC impacts.

The results of this sub-phase allow the user to determine the list of CC impacts to be treated as a priority.

**Step 2-Phase 2-Subphase 2.2**: the aim of this sub-phase is to estimate the RB's adaptive capacity. The TMCC considers CC adaptive capacity (AC) as "the ability of the RB to moderate CC potential damage and take advantage of existing opportunities to operationalize the mainstreaming process."

An analysis has been undertaken to identify key indicators to assess the AC at the RB level. 8 indicators are selected and adopted by the TMCC to estimate the AC. The selected indicators list is not exhaustive; it presents significant markers that provide information about the RB's AC. The estimation of these indicators permits to identify 5 levels of AC.

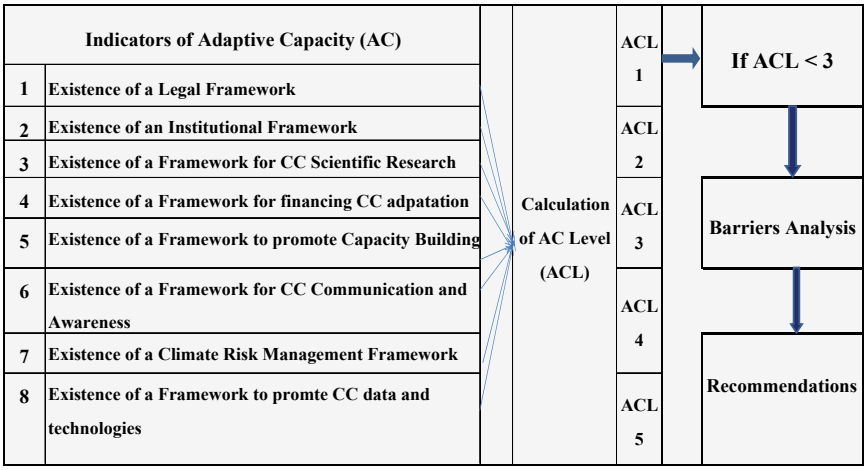


**Fig. 3** Design of the Step 2, Phase 2, Sub Phase 2.2 of the TMCC

Figure 3 presents the design of the Step 2, phase 2-sub-phase2.2 of the TMCC. It represents the 8 selected indicators and the 5 levels of AC. Level 1 of AC indicates that tools, institutions, and mechanisms which create mainstreaming process implementation opportunities are not available. Level 2 of AC indicates that these tools, institutions and mechanisms are available. Level 3 of AC suggests that the local government is engaged in implementing these tools and mechanisms (the local government has recently administered these tools into their agenda and other essential issues in the government agenda). Level 4 of AC indicates that the implementation of these tools and mechanisms are limited. Level 5 of AC implies that the implementation plan of these tools and mechanisms are advanced.

Figure 3 shows that the TMCC has adopted level 3 of AC as a reference level required to operationalize mainstreaming process implementation. Indeed, if AC is less than 3, the TMCC suggests conducting a barriers analysis. This analysis is related to the 8 selected areas of opportunities; furthermore, the TMCC presents recommendations to overcome barriers and make progress in the mainstreaming process implementation.

**Step 2-Phase 2-Sub-phase 2.3**: this sub-phase aims to analyze barriers that inhibit mainstreaming process implementation. PESTEL analysis has allowed identifying 12 barriers:

- Limited government prioritization of mainstreaming process at the local level
- Poor coordination between National and Local Government
- Difficulty to access climate funds
- Limited financing mechanisms to strengthen the mainstreaming process
- Limited involvement of local community
- Limited ways to build on local traditional knowledge and practices
- Limited belief and understanding of CC's impact at local level

- Limited knowledge and expertise on CC issues
- Inadequate data and information related to CC
- Limited knowledge of the value of ecosystems that contribute to the WR development
- Lack of mechanisms for environmental protection
- Difficulties in applying water law.

This list is not exhaustive; it includes some significant barriers that can inhibit mainstreaming process implementation in the water sector.

The results from Step 2, phase 2, sub-phase 2.2 allow the user to estimate the RB's AC. If the AC is less than 3, sub-phase 2.3 allows the user to obtain the list of barriers that inhibit the implementation of the mainstreaming process.

**Step 3 of the TMCC: Identification and Prioritizing Actions for CC Adaptation**

The purpose of this step is to identify CC adaptation actions and prioritize them, as it has been acknowledged that we cannot implement all of the identified actions at the same time. To minimize CC impacts on vulnerable units, the TMCC offers a list of 60 adaptation actions and adopted six strategic axes related to the six most vulnerable units identified above.

The TMCC allows users to classify adaptation actions into six groups of Actions (GA1; GA2; GA3; GA4; GA5; GA6). GA1 includes actions with high priority. The actions of the GA6 and GA5 are not necessarily optional or urgent; often, it is their essential cost that downgrades them; therefore, there is a need to search for significant additional investment to achieve these actions.

The Climate Proofing for Development (CPDev) approach, developed by the GIZ (GIZ 2011), has been used to prioritize adaptation actions at the RB level. The TMCC has adopted this approach based on the following aspects: (i) CPDev is an approach that allows to mainstreaming adaptation actions into existing development plans (GIZ 2011); (ii) CPDev is an approach that uses criteria adapted to the water sector context (Stour and Agoumi 2013); (iii) CPDev is based on principles that considered the socio-economic and political aspects (GIZ 2011).

According to the CPDev approach, Table 1 presents the criteria adopted by the TMCC to prioritize adaptation actions and the rating scores. Rating scores are identified on a scale of 1–5, 1, meaning the lowest intensity, and 5 meaning the high intensity to reduce CC vulnerability while applying the identified actions.

The results of the TMCC's Step 3 allow users to have a list of prioritized adaptation actions to be urgently implemented.

**Step 4 of the TMCC: Integration of Prioritized Actions into the IWRDP**

Step 4 of the TMCC allows the user to integrate a prioritized list of adaptation actions into the IWRDP. At this stage, the TMCC presents guidance for the separation of new actions, and those already emphasized in the IWRDP. Furthermore, the TMCC offers an opportunity to achieve a conformity test with the PESTEL context. According to the results of this test, congruent actions with the PESTEL context are directly

**Table 1** Scoring criteria

| Key criteria | Designation | Qualification (Q) | Scores |
|---|---|---|---|
| C1 | Cost of Identified Action | **Q1**: Very High cost: national government or international organizations will support the cost<br>**Q2**: High cost but the region can support the cost<br>**Q3**: Medium cost tolerable by the city<br>**Q4**: Low cost supportable by the commune<br>**Q5**: Very low cost supportable by a group of people | 1<br>2<br>3<br>4<br>5 |
| C2 | Intensity of vulnerability reduction ensured through the implementation of the identified action | Huge spread of intensity<br>Very high intensity<br>High intensity<br>Medium intensity<br>Low intensity | 5<br>4<br>3<br>2<br>1 |
| C3 | Scope of the adaptation action | At familial level<br>At the village level<br>At the commune level<br>At the city level<br>At the region level | 1<br>2<br>3<br>4<br>5 |
| C4 | Actions with/without regret | Actions with regret<br>Actions without regret | 1<br>2 |
| C5 | Action implementation | The action is difficult to implement<br>The action is easy to implement | 1<br>2 |

integrated into the IWRDP. However, the non-congruent actions must be modified and adjusted to the PESTEL context, facilitating its integration into the IWRDP.

The results of this Step allows user to dispose of: (i) the list of the adaptation actions emphasized in the IWRDP to be integrated directly in the IWRDP; (ii) the list of actions emphasized in the IWRDP to be adjusted; (iii) the list of new actions to be integrated directly in the IWRDP; (vi) the list of new actions to be adjusted or modified to facilitate their integration into the IWRDP. Therefore, these results permit to update the current IWRDP, which provides a practical basis plan for the next 5 years.

**Step 5 of the TMCC: Financing Prioritized Adaptation Actions**

The prioritized actions must be implemented, which requires funding resources. If the decision-maker has these resources, it could go directly to implementation. Otherwise, the TMCC offers an approach to guide the decision-maker to access climate funds.

The prioritized actions can be grouped on Program of Actions (PA). The TMCC has adopted an approach to evaluate the PA's chances to access climate funds. This approach is based on the evaluation criteria developed by the European Union within

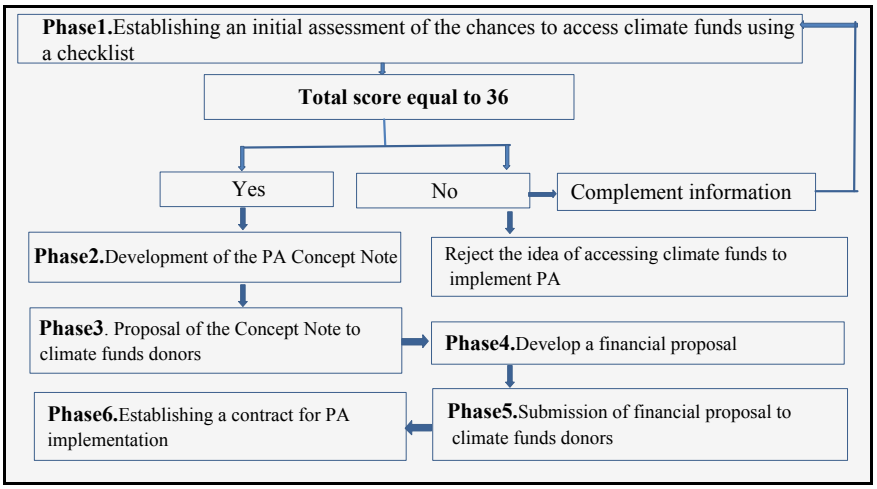


**Fig. 4** Design of the step 5 of the TMCC (Stour 2017)

the ClimaSouth project (ClimaSouth 2016). Indeed, a checklist has been established based on the five keys developed within the ClimaSouth project: (a) description of action; (b) expected results; (c) compliance with national priorities; (d) clarity of the implementation plan; and (e) estimation of the budget and co-financing indicative (ClimaSouth 2016).

The five keys outlined above include 12 aspects required by climate fund donors. These aspects provide specific information and issues to consider in order to access climate funds. In this regards, three scores have been identified for each aspect to assess the availability of information required by climate donors (CD) (i): No information is available; (ii): Information partially available, with a chance to be provided later; (iii): Information is fully available.

Figure 4 presents the procedure adopted by the TMCC to guide decision-makers to access climate funds.

The results of the TMCC's Step 5 allow the user to determine the chances of accessing climate funds for action or PA implementation.

### Step 6 of the TMCCC: Implementation Process

To facilitate the implementation process, the TMCC suggests to develop an implementation strategy with the following considerations: (a) identify key stakeholders and their responsibilities; (b) specify the implementation delays; (c) develop methodological guides to facilitate implementation; (d) ensure synergies between sectors: water-energy-food security; (e) strengthen coordination with RB neighbors communities; (f) mobilize civil society; (g) strengthen capacity building of the TF representatives; (h) develop communication strategies and awareness (websites to share information and results); (i) create some Champion patterns for implementation.

The results of Step 6 provide users with further guidelines regarding the implementation process. At the same time, the established TF will monitor the integration of the prioritized adaptation actions into the newly revised water plan during the five coming years considering CC science innovation and local community evolution.

**Step 7 of the TMCC: Monitoring and Evaluation**

The TMCC has adopted the monitoring and evaluation (ME) method generated from a local approach. This approach enables identifying quantitative and qualitative indicators that emphasize effectiveness and the role of mainstreaming adaptation action into existing plans, policies, and budgets at the local community level (Bours et al. 2013). The TMCC suggests some ME indicators that characterize barriers inhibiting the PA process implementation. These indicators are harmonized with the barriers outlined above. Table 2 presents the ME indicators adopted by the TMCC.

The results of the TMCC's Step 7 allow the user to have a guiding mechanism for monitoring the implementation.

## 3 Results

The TMCC has been tested in the two RBs of Loukkos (LRB) and Tensift (TRB). The data used to generate results is collected from the Loukkos RB agency (LRBA) and the Tensift RB agency (TRBA). The available data are collected during 1960–2016, especially in the Tangier station (LRBA) and Marrakech station (TRBA).

### *3.1 Presentation of the Loukkos and Tensift River Basins*

In Morocco, each river basin is managed by an agency according to the 10–95 water law. The agency is responsible for the advancement of the water development plan and procedures for water management. It is also responsible for data collection, data analysis, and data compilation for water management at the RB level.

In 2012, the LRBA and the TRBA developed their IWRDP that presents WR status and identifies potential solutions to ensure water security within the RB. However, these plans did not include CC impacts and considerations. Therefore, the LRBA and the TRBA are currently instructed by the national authority to update their IWRDP to anticipate and mainstream CC issues into the new water development plan.

The area of actions of the LRBA presented in Fig. 5 is located in the north of Morocco. Studies available for the LRB announced trends of decrease in annual average rainfall of −10 to −20% during 2016–2035 with a pronounced decreasing trend (−30%) during 2081–2100 (M.E 2016). Furthermore, these studies announced: (i) trends of increase in annual average temperatures of 4–5 °C at the 2100 horizon (M.E 2016); (ii) an accelerated Mediterranean Sea level rise that may exceed 90 cm during the end of this century (M.E 2016).

**Table 2** Indicators for monitoring-evaluation process

| Aspects | ME Indicators | Key elements of characterization | Score |
|---|---|---|---|
| Policy | Local government priority | PA implementation is not in the local government agenda | 1 |
| | | local government has just put PA in his agenda (other issues are important in the government agenda) | 2 |
| | | PA is a priority in the local government agenda | 3 |
| Institutional | Availability of processes for coordination between national and local government | Coordination processes not available | 1 |
| | | Coordination processes available, but not easily implemented or inadequate | 2 |
| | | Coordination processes available and easily implemented | 3 |
| Financial | Availability of mechanisms to support local actors to implement PA | Public mechanisms not available | 1 |
| | | Public mechanisms available but not easily understood or inadequate | 2 |
| | | Public mechanisms available and easily implemented | 3 |
| Social | Availability of mechanisms to inform vulnerable groups | Mechanisms not available | 1 |
| | | Mechanisms available, but not easily understood or inadequate | 2 |
| | | Mechanisms available and easily implemented | 3 |
| Technical | Availability of climate scenarios and process to strengthen capacity building | Scenarios and capacity building process not available | 1 |
| | | Scenarios and capacity building processes available but not easily understood or inadequate | 2 |
| | | Scenarios and capacity building processes available and easy implemented | 3 |
| Environmental | Availability of environmental protection mechanism to strengthen PA implementation | Mechanisms not available | 1 |
| | | Mechanisms available, but not easily understood or inadequate | 2 |
| | | Mechanisms available and easily implemented | 3 |
| Legal | Availability of legal mechanism to strengthen PA implementation | Mechanisms not available | 1 |
| | | Mechanisms available, but not easily understood or inadequate | 2 |

(continued)

**Table 2** (continued)

| Aspects | ME Indicators | Key elements of characterization | Score |
|---|---|---|---|
| | | Mechanisms available and easily implemented | 3 |


**Fig. 5** The LRBA area of action

The area of action of the TRBA presented in Fig. 6 is located in the Midwest of the country. Climate projections available for the TRB show that according to the optimistic scenario (RCP 2.6), annual average temperatures will increase by 0.5–1 °C during 2016–2035 and by 1.0–2.5 °C during the end of this century (M.E 2016). However, according to the pessimist scenario (RCP 8.5) results, the annual average


**Fig. 6** The TRBA area of action

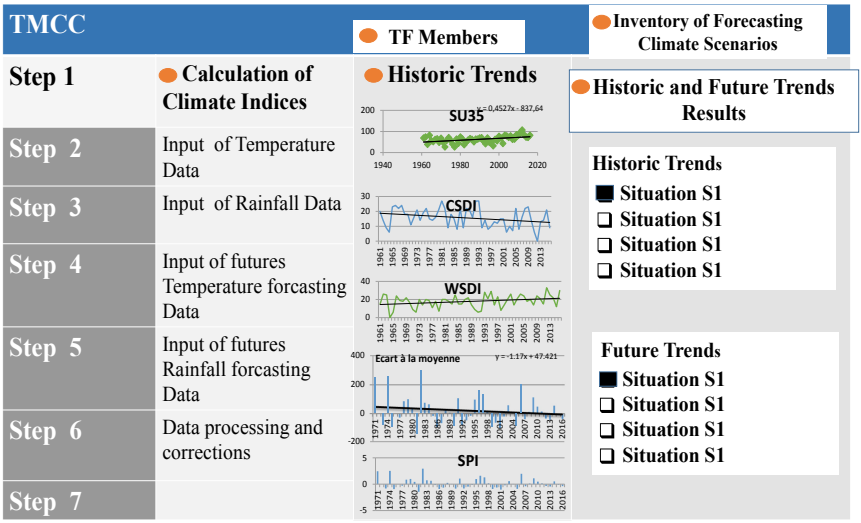


**Fig. 7** Results of the step 1: case of the Loukkos River Basin

rainfall will decrease by −10 to −20% on the 2065 and by −40% on the 2100 horizon (M.E 2016). Furthermore, the results from the pessimist scenario show that the annual average temperature will increase from +1.5 °C to +4 °C on the 2065 horizon and +5 °C to +7 °C by the end of this century (M.E 2016).

### Results of Step 1 of the TMCC

The results of Step 1 are quite similar for the two RBs. Figure 7 presents the results from Step 1 of the LRB. It shows that situation S1 (increased temperature and decreased rainfall) characterizes the LRB's historical and future trends. However, there is a need to note that: (i) the results of TRB present pronounced historical and future warming trends compared to the LRB; (ii) the results of TRB present pronounced historical and future trends of a decrease of rainfall compared to the LRB.

### Results of Sep 2 of the TMCC

Six vulnerable units have been identified for the two RBs: (a) water supply; (b) water demand; (c) water quality; (d) infrastructure, people and economic activities; (e) water governance; and (f) coastal zone. The lack of information regarding the coastal zone of the TRB has excluded this vulnerable unit from the study. Consequently, only five vulnerable units are considered in the case of the TRB.

The results of Step 2-phase 1 of the TMCC show that 52 CC impacts have been inventoried in the LRB (22 biophysical impacts and 30 socio-economic impacts), while 44 CC impacts have been inventoried in the TRB (18 biophysical impacts and 26 socio-economic impacts).

| TMCC | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Steps | AC Indicators | | Score of Adaptive Capacity adopted by the TMCC | | | | | | Estimation of AC Level |
| Step 1 | 1 | Existence of a Legal Framework promoting mainstreaming process implementation | 1 | 2 | 3 | 4 | 5 | 6 | 3 |
| Step 2 P 1 | 2 | Existence of an Institutional Framework promoting mainstreaming process implementatio | 1 | 2 | 3 | 4 | 5 | 6 | 3 |
| Step 2- P2- SP 2.1 | 3 | Existence of a Framework enhancing Scientific Researches related to CC | 1 | 2 | 3 | 4 | 5 | 6 | 1 |
| Step 2- P2- SP 2.2 | 4 | Existence of a Funding Framework promoting mainstreaming process implementatio | 1 | 2 | 3 | 4 | 5 | 6 | 1 |
| Step 2- P2-SP 2.3 | | | | | | | | | |
| Step 3 | 5 | Existence of a Framework improving Capacity Building | 1 | 2 | 3 | 4 | 5 | 6 | 2 |
| Step 4 | 6 | Existence of a Communication Framework | 1 | 2 | 3 | 4 | 5 | 6 | 1 |
| Step 5 | 7 | Existence of a Framework for CC Risk | 1 | 2 | 3 | 4 | 5 | 6 | 3 |
| Step 6 | 8 | Existence of a Framework for promoting climate data and technology development | 1 | 2 | 3 | 4 | 5 | 6 | 3 |
| Step 7 | | | | | | | | | |
| Level of Adaptive Capacity within the Tensift RB (Average) | | | | | | | | | 2 |

**Fig. 8** Results of Step 2, Phase 2, Sub-phase 2.2 of the TMCC: Case of the Tensift RB

The results of Step 2-phase 2-sub-phase 2.1 of the TMCC are quite similar for the two RBs. The following CC impacts are classified as impacts with a high level of risk (catastrophic risk): (a) loss of human lives; (b) water scarcity; (c) increased cost for water treatment; (d) increased water demand and (e) limited institutional tool. Furthermore, the increased sea level and the loss of livelihoods are also impacts classified with very high risk in the case of the LRB where the coastal area has been studied.

The results of Step 2-phase 2-sub-phase 2.2 of the TMCC are similar for the two RBs. Figure 8 presents the results of the sub-phase 2.2 of the TMCC for the TRB. It shows that the average level of AC of this RB is estimated at 2. Therefore, according to the TMCC procedures outlined above, this level of AC when less than 3 requires analyzing barriers that inhibit mainstreaming process implementation.

The results of the sub-phase 2.3 are also similar for the two RBs. These results show that all barriers (12 barriers) adopted by the TMCC are identified as major barriers that inhibit the mainstreaming process implementation within the two RBs

### Results of Sep 3 of the TMCC

The prioritizing process is applied according to the TMCC procedures outlined above. The results of Step 3 show that the cost of identified action (C1) and the intensity of vulnerability reduction ensured through the action implementation (C2) are identified as weighing criteria playing an essential role in the prioritizing process within the two RBs. The results also show that most proposed actions concern water governance (18 proposed adaptation actions).

The classification of adaptation actions on GA is applied according to the TMCC procedures outlined above. The findings show that priority is given to water governance. Indeed 100% of the GA1 actions (GA1 presents the highest priority action group) are required for improving water governance within the two RBs. This result does not mean that the actions of the other strategic axes are less important; however, it seems that the success of mainstreaming process implementation required strong action on water governance that can support overcoming challenges of the other strategic axes as well as political, institutional, legal, human, and financial challenges.

**Results of Step 4 of the TMCC**

According to the TMCC procedures outlined above, the results from step 4 of the TMCC show that the conformity test has allowed identifying actions already outlined in the IWRDP. These need to be reinforced to make it easier to mainstream (22 actions within the LRB and 23 actions within the TRB). The conformity test has also permitted to identify the new actions congruent with PESTEL aspects (30 actions within the LRB and 21 actions within the TRB). These results permit to have a practical and completed new plan for the next 5 years.

**Results of Step 5 of the TMCC**

The LRBA and the TRBA are preparing a PA, including prioritized actions related to 'water governance'. The PA will be submitted shortly to the climate funds for approval. The chances of funding the PA have been estimated to 24 for the two RBs, which explains the lack of information required by climate donors. Consequently, the LRBA and the TRBA are currently focusing their efforts on providing complementary information to achieve the financing process described in Fig. 4.

**Results of Step 6 of the TMCC**

The LRBA and the TRBA are preparing the implementation strategy.

**Results of Step 7 of the TMCC**

The LRBA and the TRBA establish a ME system that will monitor the progress of the mainstreaming process implementation.

## 4 Limitations

The mainstreaming process should be designed within an integrated territorial perspective considering synergies between various development sectors. Some identified adaptation actions have considered this perspective; however, the ability to design the territorial approach in its overall vision is a limitation of the TMCC's structure.

The TMCC provides a list of barriers to the mainstreaming process based on the PESTEL analysis; it does not claim to record all possible mainstreaming process

barriers. Furthermore, the methodology used did not trait barriers interconnections analysis, which is a limitation of this work.

The TMCC has adopted an extensive list of clear indicators to monitor the mainstreaming process based on the PESTEL analysis. It does not claim to record all possible indicators that can monitor the implementation progress, which is a limitation of this work.

A small sample size of respondents, from national and local levels, was interviewed to discuss different steps of the TMCC, which is a limitation of this work. The constraints of time and resources have prevented conducting a large sample size of respondents.

## 5 Conclusion

Climate change is one of the greatest challenges for the present and future generations; it has threatening consequences in the water sector at the core of economic growth. The need to mainstream CC into the water development plan is growing and increasingly recognized by the political community. However, despite growing attention to support mainstreaming, there is a need to close the implementation gaps.

The international community has undertaken considerable efforts to support countries to implement mainstreaming processes; the undertaken efforts have enriched the literature but did not provide a clear answer on "how to implement in a practical and operational way mainstreaming process on the ground?".

The challenges of closing the implementation gaps are decreasing as there are movements in considering the inter-linked PESTEL aspects ensemble and assessing barriers and synergies, explaining the complexity of implementing the mainstreaming process.

The TMCC has considered the analysis of PESTEL aspects ensemble and barriers showing support for decision-makers to operationalize the mainstreaming process on the ground. It contributes to enrich the literature through the main finding: a systematic methodology that decision-makers can use to update the water development plan considering CC and promoting climate resilience within the RB.

The application of the TMCC in the Loukkos and Tensift RB has allowed updating the water development plan considering the main results: future climate trends are moving towards an increased temperature and a decreased rainfall, which requires specific actions to overcome this challenge.

Loss of human lives, water scarcity, increased water demand, and inadequacy of the institutional tools are the impacts classified with very high risk to be anticipated. The increased sea level and the loss of livelihoods are also impacts classified with very high risk in the case of the LRB where the coastal area has been studied.

This working paper encourages decision-makers to improve water governance based on its role and power leverage to better and operationalize the mainstreaming process. Barriers related to governance, political and institutional aspects should

most certainly be addressed in the early stages of the mainstreaming process implementation.

Barriers interconnections analysis is not expected in this work; it is a complex process that needs specialized focus. Accordingly, the barrier interconnections analysis can be further improved depending on the needs of future researches.

The monitoring and evaluation indicators help planners follow the progress of mainstreaming process and generate more robust and resilient program actions. However, the identified indicators can be further updated, including vulnerability and climate risk indicators depending on future research needs.

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