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Report

Sustainable water management for resilience to climate change impact on society in South Africa (SUWAM)

Final results report to the Norwegian Research Council

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ABSTRACT
The report presents the key findings from the project Sustainable water management for resilience to climate change impact on society in South Africa. The project was carried out as a collaboration between SINTEF and Stellenbosch University, with Hessequa Municipality as a partner. The project was funded as a 3-year research project by the Norwegian Research Council and the Research Council of South Africa under the SANCOOP programme. The overarching project objective was to enhance resilience to climate change impacts (CCI) on society. The chosen perspective is the water sector and impacts caused by changes in water related ecosystem services (ESS) and effects on man-made water cycle services (WCS). Results from the project are reported in five papers, one for each of the sub-chapters of chapter 2 in this report. Two MSc students, one at Stellenbosch and one at NTNU, were associated with the project and provided valuable results that have been included in the papers from the project. The research team has worked in close collaboration with Hessequa Municipality during visits to Riversdale and gratefully acknowledges the contributions from Hessequa Municipality.

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1 Introduction, objectives and related tasks

The report presents the key findings from the project *Sustainable water management for resilience to climate change impact on society in South Africa*. The project was carried out as a collaboration between SINTEF and Stellenbosch University, with Hessequa Municipality as a partner. The project was funded as a 3-year research project by the Norwegian Research Council and the Research Council of South Africa under the SANCOOP programme.

The overarching project objective was to enhance resilience to climate change impacts (CCI) on society. The chosen perspective is the water sector and impacts caused by changes in water related ecosystem services (ESS) and effects on man-made water cycle services (WCS). The specific goals were to: 1) Map the current status and predicted CCI on water resources and related ESS with a focus on their impacts on society in Hessequa Municipality; 2) Assess the WCS of a selected settlement with a view to the identified CCI on water resources and related ESS, by social, economic and environmental sustainability analyses; 3) Develop a holistic methodology for evaluation of CCI on society that can be used as a tool in implementation of integrated water resource management strategies, whilst assessing and improving resilience to CCI on society at a local scale; 4) Build capacity on CCI and sustainable water management among public and private stakeholders, and in the participating research institutions.

The activity was carried out in five work packages, relating to the project goals. The mapping of CCI (WP2) was done mainly by Stellenbosch University, in dialogue with SINTEF. SINTEF was in charge of the WCS assessment (WP3), and the development of a holistic method for sustainability assessment (WP4), with contributions from Stellenbosch University. Project management and quality assurance was defined as WP1, and a responsibility shared between the partners, while WP5 consisted of dissemination and impact evaluation, with Stellenbosch University in charge.

2 Overview of results and conclusions

2.1 Climate data and water resources

To enable research towards climate change impact (CCI), different types of data were needed. The accessibility of climate data was, however, quite problematic, as sources within the catchment were limited to rainfall measurements at the Korentepoort dam. The climate data generated by the CSIR in South Africa (considered as the official data source), was averaged over a 50 km pixel basis, covering the Korentepoort catchment and the surrounding region. One must be aware of the rainfall distribution pattern (Figure 1). However, a decreasing trend till 2045 with a general 50 year cyclicity was clear, and that the Korentepoort dam will receive both summer and winter rain, but all indications are that it will become drier till 2045.

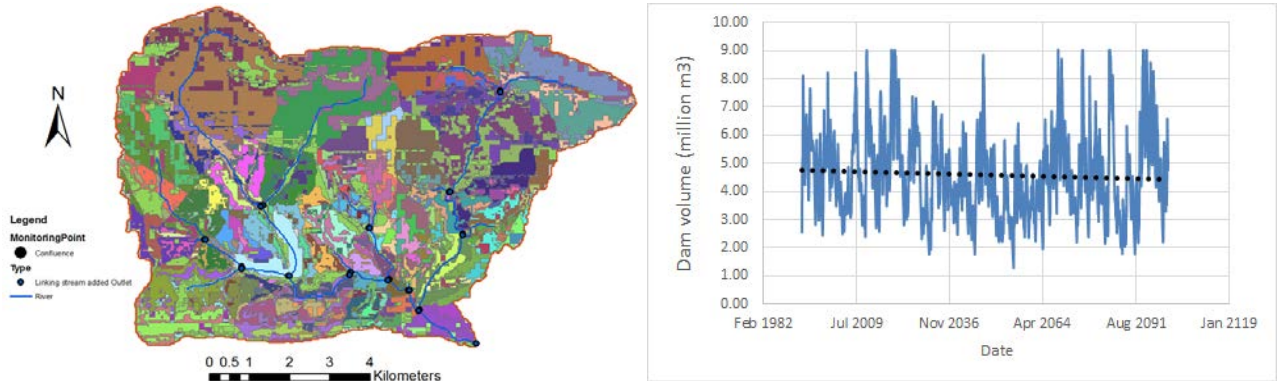

Figure 1. HRU map (left) and modelled water volume in the Korentepoort dam (right).

Hydrological models use soil physical properties together with rainfall intensity, terrain and antecedent moisture content to ultimately determine the amount of surface runoff and drainage. The boundaries between different hydrological soil groups are solely derived from soil morphology. However, the scale of the available Land Type maps did not permit accurate prediction. Morphological mapping of the catchment was therefore performed, and a Hydrological Response Units (HRU) map was generated with the hydropedology map, land use maps and slope classes using the SWAT model (Soil Water Assessment Tool) (Figure 1). Modelling of the Korentepoort dam volume made use of published results and predictions from the Department of Water Affairs (DWA).

2.2 Sustainability assessment of WCS

A framework for integrated sustainability assessment of water cycle services was developed using the town of Riversdale as a case. The sustainability assessment framework (SAF) had 29 criteria covering the dimensions: social, environmental, economic, governance and assets, which measured the performance in relation to locally defined goals for sustainable development of the society. The assessment, using mainly local data, showed challenges for some criteria but also good performance for other criteria in all dimensions of sustainability.

The assessment with the SUWAM framework was compared with two other sustainability assessment frameworks: TRUST, from the EU-project TRUST, and City Blueprint, developed in an EIP-water action group. The comparison of the results from the different frameworks demonstrate that a sustainability assessment framework must be tailored to the local conditions in the case that is assessed, and that the perspective of the user, often a decision maker must be taken into account in the interpretation of the results. The methodology used in the development of the SUWAM framework, where the point of departure was the local plan for sustainable development, fulfilled these two criteria and therefore produced a sustainability assessment of the WCS with results that were relevant for the studied case and recognised as such by local stakeholders.

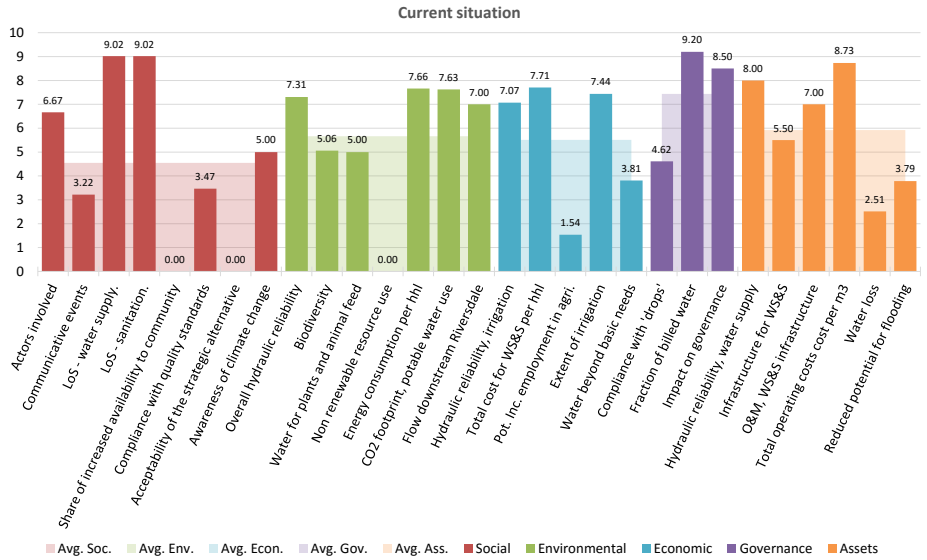

Figure 2. Sustainability of the current WCS assessed with the SUWAM-framework

2.3 Holistic assessment using the SAF and multivariate analysis

The developed methodology is suited for comparing and further analysis of different mitigation and adaptation measures. During the project, several strategic options were identified to address the challenges. They were of different types, some purely technical, others focused on governance, and covered both

measures that would only be implemented and have impact in Riversdale and measures that would be implemented and have impact also in the surrounding areas. Implementation of the strategic options could partly be decided by the municipality, but some also involved other stakeholders at national level *e.g.* DWA.

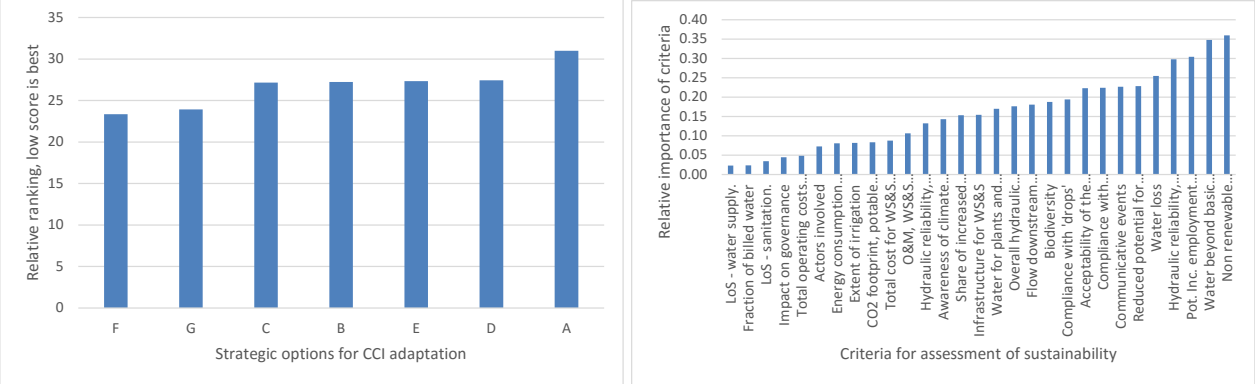

Figure 3. Ranking of strategic options (left) and relative importance of the SAF criteria (right).

The strategic options considered in the assessment were: A) Continue with business as usual – status quo; B) Add additional water source – (Enlarge the Korentepoort dam/new dam in Kristalkloof); C) Change water allocation system; D) Change land use in catchment; E) Change WCS towards water re-use; F) Reduce water loss from main pipe from weir, now at >30%; G) Improve demand management. The sustainability of the different options was assessed by comparing the expected situation after 35 years with the current situation. For the scenario of 10% reduced rainfall in summer and winter, and continuation of business as usual with respect to adaptation and mitigation measures the comparison showed a negative development for some criteria, and especially regarding sufficient water for the town's water supply. Comparison of all the alternatives using principal component analysis, showed that measures to reduce leakages (F) and improve demand management (G) were ranked highest when assessed with equal weighting of the criteria in the different sustainability dimensions (Figure 3). However, the analysis indicated that none of the strategies would be sufficient alone to address all the sustainability criteria with a low score, and that several measures would be needed for a sustainable adaptation of the WSC to expected climate change impacts.

2.4 Impacts on society

In addition to the quantitative assessments, the impacts on society were elaborated in interviews and discussions with stakeholders throughout the project period. The findings underscore that socioeconomic conditions, as well social networks, local knowledge and non-climatic pressures are inherent in local adaptation processes. In their views and arguments regarding specific adaptation measures, stakeholders made frequent references to history, migration, unemployment, race and culture. There was a strong political dimension, but also a concern among many to try and leave *"political"* aspects out of the picture, in order to keep the local environment stable and attractive.

This seemed to influence the municipality's approach. Despite the efforts to link adaptation to South Africa's national development objectives, the approach in Hessequa was technical-environmental. This was also linked to the somewhat unclear mandate at municipal level, as well as lack of capacity and limited communication and coordination across levels and sectors. The technical-environmental perspective directed attention to scientific detail and away from broad stakeholder involvement, contributing further to an incremental, rather than transformational approach.

The stakeholder dialogue through the project indicates that on some points, municipal staff underestimated the public's willingness to change and accept new solutions. It also shows how local authorities and knowledges tended to reproduce existing subjectivities and power relations. In some ways, this limited the communication and scope for adaptation. However, several stakeholders also challenged and resisted the

established structures. Moreover, there were indications that new subjectivities linked to green behaviour were emerging and associated with innovative as well as adaptive potential.

Beyond showing that adaptation is political all the way through, the complexity and dynamism observed in the studied case underscore the need for governance approaches that facilitate multi-actor collaboration. To overcome the identified barriers and achieve synergies between adaptation and other development objectives, it is necessary to tap into the multiple perspectives and knowledges constructed. This requires forums and tools that enable more participative and holistic assessment of alternative adaptation strategies.

2.5 Expected impacts of the project

The Payback-Eco Framework was used for the purpose of a mid-project evaluation of the project. The findings were that the SUWAM project has directly impacted on knowledge production (80% positive responses), and the respondents were unanimous in that the project will contribute in the future. Respondents were more divided in their views regarding impacts on policy, but unanimous in that whatever impact there had been, had been indirect, and that the SUWAM project likely will impact policies positively in future. The response (mostly from municipal officials) was positive (46%) that the SUWAM project has already had a positive contribution to societal benefits (68% indicating direct impact), and that the SUWAM project will have a positive contribution to societal benefits in future (72%). Participants were evenly divided between being positive with respect to current impact on the ecological environment, and having no current impact. Participants were, however, positive (88%) that the SUWAM project will have a direct positive impact on the ecological environment in future.

The mid-project coordinators' survey was found to be effective in determining a 'snap-shot' of research project participants views and experiences with regards to the impact the SUWAM project has had on various dimensions, and further anticipated impacts.

3 Implementation, dissemination and future work

The project was executed through five visits by SINTEF to South Africa and four visits by Stellenbosch University to Norway, as well as work carried out in between visits. Two MSc students, one at Stellenbosch and one at NTNU, were associated with the project and provided valuable results that have been included in the papers from the project. The research team has worked in close collaboration with Hessequa Municipality during visits to Riversdale and gratefully acknowledges the contributions from Hessequa Municipality.

Results from the project are reported in five papers, one for each of the sub-chapters of chapter 2 in this report. Of these two have been submitted for publication, while three are in preparation and will be completed after the closing of the project. Results have also been disseminated throughout the project period in five workshops/meetings with participant from stakeholders in South Africa (Hessequa Municipality, local stakeholders in Hessequa, CSIR, Department of Science and Technology (DST), Water Research Commission (WRC) and Department of Water Affairs (DWA)) and Norway (Nordre Fosen Vannområde (local catchment agency)). In addition to dissemination towards targeted audiences, the project has received news coverage in three newspaper articles and one web page in South Africa, and in one Norwegian radio program.

The developed sustainability assessment methodology has been included in four project proposals, two international, and two in Norway of which one has been funded and the other is under evaluation. Future work in addition to completion of three papers, include a meeting in February 2017 for discussing the potential further uptake of the SAF methodology in Norway with Norsk Vann (user association for the Norwegian municipal water service providers), and possible participation to upcoming WRC event in South Africa discussed a meeting with CSIR and DST/WRC organised by Innovation Norway in November 2016.

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