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Designing water security solutions, Makassar Indonesia

Enhancing the effective and sustainable urban water system for Makassar, a rapidly growing Indonesian city already facing water shortages and vulnerable to a changing climate.

Australian Aid

BMKG

TIRTA DHARMA

The issue

As an archipelago country, Indonesia is vulnerable to the impact of climate change. Makassar, the capital city of the South Sulawesi Province, is the most urbanised city in the eastern part of Indonesia with a population of more than 1.2 million (2006). Makassar is already struggling to meet the demand for clean water supply, in 2012 only 62% of the population had access to mains water supply. Increasingly, climate change and its subsequent impact will likely exacerbate an already critical situation. There is limited knowledge available for informing climate adaptation at the local scale, and the capacity of local institutions needs to be enhanced to enable them to incorporate mainstream adaptation and mitigation responses into local development planning.

Our approach

A collaborative project was designed to develop an understanding of Makassar's current and future water security, and identify sustainable adaptation strategies. In addition, the project was designed to build local capacity to mainstream climate change considerations into development planning. The project was undertaken using a combination of top-down (projections) and bottom-up (observations) approaches. The identification of adaptation options was performed by utilising Integrated Urban Water Management (IUWM) principles which consider the overall water cycle in the management of water supply, stormwater and wastewater. Our approach allowed for the assessment of a diverse range of water service options, as well as the consideration of certain criteria (e.g. adaptability) to anticipated climate change impacts. The project was managed as a partnership between CSIRO and Hasanuddin University.

DFAT-CSIRO Research for Development Alliance

This project was funded by the Research for Development (R4D) Alliance, a strategic partnership tackling complex development challenges in the Asia Pacific region

Key lessons for development

- Addressing water security involves more than just building bigger dams. Better solutions can be attained by combining infrastructure and preventative measures, such as demand management and behaviour changes.
- Water stakeholders in Makassar now share similar views regarding water resources, which means they are well placed to start developing adaptation thinking and practices.
- Two adaptation strategies, broken down into twelve options, were identified to help the City sustain its urban water supply under a changing world.
- The projections suggest a potential decrease in rainfall over Makassar, a shortening of the wet monsoon and an increase in evaporation. Subsequently, these projected changes will effect future streamflow in the catchments around Makassar.
- The population of Makassar is expected to increase by 20% by 2020, and, as people become more affluent and more connected to mains water supply, water demand is expected to increase by more than 120%.

Project partners

This 3 year collaborative project was led by CSIRO and Hasanuddin University (UNHAS), in partnership with the Bureau of Meteorology, Climatology and Geophysics (BMKG – National office and Makassar regional office); PPE: State Ministry of Environment – the EcoRegion Management Center for SUMAPAPUA, Makassar; PDAM: Municipal Water Supply Company, Makassar; PU: Public Work Agency, Makassar; BLHD: Environmental Agency, Makassar and the Australian Department of Foreign Affairs and Trade (DFAT).

Key achievements

OUR STORY			
What did the project deliver?	**Fine-resolution climate change simulation and projections** were developed to inform climate change impact and adaptation assessments on a local scale. In addition, the project developed projections for stream flow and soil erosion for the MAMMINASATA region. Outputs included the production of briefing papers, fact sheets, reports, data and journal papers.	**A set of adaptation options and implementation strategies** to improve water provision sustainability for the city were proposed (some examples are shown on page 4). This included developing an understanding of Makassar's current and future challenges associated with the water security, as well as assessing the suitability of the Infrastructure Master Plan to meet demand. It concluded that infrastructure and population are both major drivers in water service problems.	**Capacity building** was a core aspect of project implementation, with opportunities for formal and informal capacity building processes. Two training workshops were conducted in Melbourne, Australia, on modelling for climate change and sustainable water service. Workshop participants gained insights from the Australian experience with regards to the planning and implementation of the integrated urban water management towards sustainable urban adaptation. Participants interacted with Australian scientists, government agencies and practitioners.
How is it being used?	Awareness of climate change projections and associated potential impacts information has been increased and it is expected that the project's results will be used in future for planning in MAMMINASATA.	A selection of the preferred adaptation options has been developed by Makassar planners and a strategy has been created to implement those options.	UNHAS emerged as a Centre for Excellence and is increasingly being asked to assist local government to address climate change adaptation and mitigation issues. UNHAS is becoming well known both nationally and internationally.
What impact did the project have?	The Public Works Agency is reviewing the Master Plan, and CSIRO has been asked to review the clean water supply Master Plan. Information developed by the project is being used by the World Bank for a new feasibility study and by the UN Habitat as a vulnerability assessment of large infrastructure in Makassar. The project has also been selected as a case study for inclusion in the Urban Climate Change Research Network's Second Assessment Report on Climate Change and Cities (ARC3-2) to be published in late 2015.	The State Ministry of Environment – the EcoRegion Management Centre for SUMAPAPUA (PPE) asked UNHAS to design the pilot demonstration for rainwater harvest and water use. In addition, PPE asked CSIRO to write a chapter about climate change and water security on MAMMINASATA Status of Environment 2013. UNHAS and the Centres for Ecoregion Management of Sulawesi, Maluku and Papua have cooperated in the establishment of a reservoir to catch rain water. The funding is being sourced from the Center for Ecoregion Management of Sulawesi, Maluku and Papua.	UNHAS received an "A" National Education Accreditation; Dr Roland Barkley, an Indonesian project champion, has been appointed to the role of UNHAS representative in the Indonesia-France Joint Working Group; and requests have been received from local government for UNHAS to undertake further work. The Centre grew from two to 17 students working on climate change impacts assessment and now has a waiting list.

Identification of adaptation options

Adaptation options for Makassar were identified and categorised as soft tools, aimed at eliciting social and behavioural change, and hard tools, comprised of technological and engineering solutions. The purpose, effectiveness and viability of the adaptation options, and the timing and sequence of implementation of multiple tools are typically context dependent and need to be tailored to the opportunities and challenges of each application area.

The experience of adaptation in both emerging and old economies is that reliance on technological solutions alone is often associated with escalating costs of infrastructure upgrade and maintenance into the future. Case studies and experiences from overseas show that there are significant water efficiencies that can be gained from community education and collaboration between government, industry and other stakeholders.

Examples of water supply adaptation options for Makassar developed in a stakeholder workshop

CATEGORY	TOOL	DETAILS	PURPOSE	ENABLER
MANAGING EXISTING SOURCES	**Absorption well (Biopori) at each house**	Installation of small absorption wells (10cm diameter) filled with organic matter across every lot in Makassar	Recharge of ground water and flood management	• Low cost technology • Legislation and funding for implementation available • Motivation: People are aware of water shortage in dry season
SOFT TOOLS	**Adult awareness program (*'sosialisasi'*)**	Dissemination of the water/environment related facts to decision-makers, industry and community	Change of mindset and attitude towards nature as precious and needed to be 'looked after'	• Needs detailed and long-term plan, with defined and measurable goals • Facilitator at DESA level • Needs real examples or demonstrations • Target audience: community and private sector
NEW SOURCES	**Recovery tank at each IPA (water treatment plant)**	Construction of tank for treatment and storage of process water from IPA (currently discarded)	Additional water supply (+7% IPA capacity)	• IPA operators are conducting feasibility analysis
NEW SOURCES	**Greywater collection and treatment**	Collection and treatment of bulk greywater discharge	Pollution reduction and possible new water resource	• Needs greater understanding of greywater characteristics and volumes
OPERATION AND MAINTENANCE	**Canal dredging**	Removal of sediment and solids from canals	Reinstate drainage capacity	• Heavy machinery • Education to change littering behaviour and reduce amount of waste disposal into canal

Impact Pathway

The project's objective was '*to help the city understand the problem and to develop solutions to improve the management of water resources*'. To this end, the research team developed an Impact Pathway consisting of three linked phases (Fig. 1a). Phase 1 focused on 'capacity building'. This enabled the allocation of resources and the development of plans, agreements and new projects to occur in Phase 2: 'policy and program development'. Following Phase 2, Phase 3: 'implementation, adoption and scaling-out would occur. These phases would cumulatively build the adaptive capacity of the project stakeholders. However, while Phase 1 encompassed the project's activities (solid line), Phases 2 and 3 were out of the project team's direct control (dashed line). Consequently, the Impact Pathway was clear for Phase 1, but less so for Phases 2 and 3.

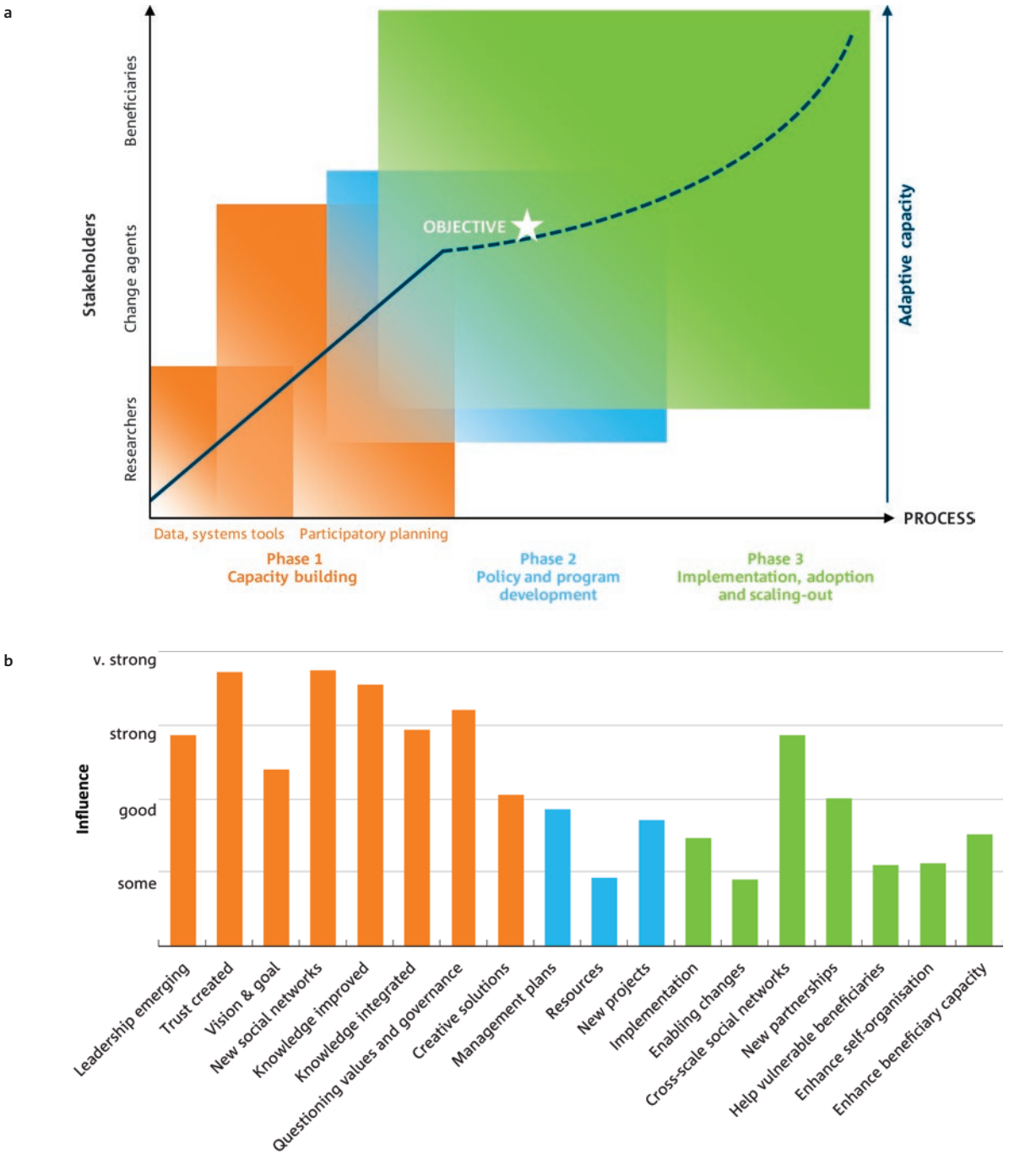

Figure 1. The project's (a) Impact Pathway and (b) influence on adaptive capacity within the Impact Pathway's three phases

Evaluating impact

To track the influence of the project on stakeholders' adaptive capacity and to enable comparisons between all Alliance projects, a standardised set of 18 indicators was developed. According to the project's Impact Pathway, each phase encompassed a progressively wider group of stakeholders and the indicators were designed to assess change among them. Fifteen researchers and change agents involved in Phase 1 were interviewed at project completion and asked to give their assessment of change by scoring each indicator, providing evidence for their scores. Results showed that there had been a positive influence for all indicators in all phases (Fig. 1b).

Phase 1: Building capacity included strong participatory engagement processes, capability development and the provision of new information for decision making. This is demonstrated by high scores, relative to the following two phases. A key aspect of this project was the exchange of ideas between local government agencies and institutions through the project workshops and communication activities. These relationships were also strengthened through training, such as the visit to Melbourne, and involving agents of change in the research activities. Consequently, an overall improvement in cooperation between institutions and sharing of information has been achieved. Overall, the project improved the trust and cooperation between individuals participating in the project, with some improvement in trust at the institutional level and increased cooperation between UNHAS and the Public Works, Meteorology and Geophysics agencies. Such cooperation has led to an opportunity to recruit new employees to work in this field, which, in turn, has led to an increase in the number of students at UNHAS.

The majority of survey respondents mentioned that theirs and others' awareness of climate change and the subsequent impact on the management of water in Makassar City had increased as a result of this project. Although the project participants developed a greater understanding of the issues and possible solutions, the government and local stakeholders are yet to implement solutions for Makassar's water needs.

Phase 2: Policy and program development had relatively less strong indicator scores, highlighting the delay and potential barrier in project knowledge influencing policy. Evidence of project influence includes the Public Works Agency, and CSIRO has been asked to review the clean water supply Master Plan. The State Ministry of Environment – the EcoRegion Management Centre for SUMAPAPUA (PPE) asked UNHAS to design the pilot demonstration for the rainwater harvest and water use.

Funding to continue this work and to implement the proposed actions is yet to be resourced. The Makassar Public Work Agency (PU) is trying to implement a current framework, but has yet to source funding for staff.

Phase 3: Implementation, adoption and scaling-out indicators scored less strongly, however, there is evidence of the project having facilitated cross-scale social networks. For example, there has been cooperation between UNHAS and the Centre for Ecoregion Management and the Agency of Environment of Makassar City, as well as with the national government and their related agencies.

There have been several new partnerships created as a result of this project, including between researchers and the Public Works Agency and the City Company for Drinking Water. At the provincial level and regency, the researchers are now involved in the preparation of the study of strategic environment and action plan for mitigation of greenhouse gas. Another new partnership is how UNHAS and the Centre for Ecoregion Management of Sulawesi, Maluku and Papua have cooperated in the establishment of a reservoir to catch rain water. The initiative and funding is from the Centre for Ecoregion Management of Sulawesi, Maluku and Papua. There has, however, been little change in water management for Makassar City. This is in part due to the short time frame between completion of the project and the evaluation, and from the lack of resourcing. The stakeholders noted that regulations need to be changed first before a change in organisation function can occur. This, however, is expected to be difficult due to the problems of complexity and bureaucracy.

This project has changed the way of thinking of researchers and stakeholders, with the Indonesian research team noting they now consider climate change and the importance of stakeholder engagement in their research practices.

Alliance wide lessons

Designing investments to assist vulnerable communities in developing countries adapt to global change (e.g. globalised markets, population growth and climate) is typically complex. This is particularly true for the Alliance where our portfolio of multi-year projects focused on global development challenges related to climate, water resources, sustainable cities, and food security. Each of the projects involved multiple actors (e.g. planning, emergency services, and primary industries) at multiple scales (local, provincial, national and global) and over time, reflecting the broad domain of R4D.

Our experience is that the context-specific nature of these investments is best served by a well-informed approach to project structure and design. Practical learning from these projects can support the development of guidance to improve aid investment outcomes. Key findings included:

- **Strong partnerships and collaboration lead to better outcomes:** Partnerships can be developed or evolve in a number of ways, all of which can be effective. Our projects included partnerships where we led, where we worked with our in-country partners to build demand, and those where we responded to demand. These partnerships were formed and evolved around relationships and purpose. A general observation is that 'pull' type projects appear to have the most clearly articulated impact pathway at the national policy level and provide the least scope for expansion; whereas co-developed or evolutionary type projects provide greater flexibility and also more opportunities to broaden partnerships over the life of projects, which can significantly improve impact. In all cases, it takes time to build appropriate, effective communication processes and trust; especially when there are cultural and institutional differences. This can be expedited through ongoing in-country presence and two-way exchanges of personnel, which provides high strategic value but carries a high operational cost.
- **Capacity building and engagement:** Engagement early on (i.e. pre-project) provides a valuable platform for co-development of projects that are then shaped by and can be responsive to local context. This has the added value of building trust between partners, which can be increased over time through capacity building initiatives. Traditional develop-deliver skillsets such as two-way mentoring, use of trusted advisors and local champions to facilitate engagement, improved project management and engagement skills, remain important; however, our experience is that conjointly developed knowledge, products and services are more context-specific and tractable.
- **Participatory approaches:** Partner institutions have high levels of connectedness with government institutions and other boundary partners – giving the research a stronger pathway to impact and increasing its relevance. Participatory approaches can improve the status of research partners and encourage buy-in from key decision-makers, which is important for longer-term support. Participatory planning approaches also strengthen formal and informal networks amongst decision-maker communities and between decision-makers and researchers, building capacity of all participants.
- **Creation of and access to data:** Datasets that are well-structured and accessible will have ongoing value. Where mandates or jurisdictions are unclear and there is a limited history of data curation and sharing, a trusted relationship between parties needs to be developed in order to overcome such procedural and institutional challenges. A trusted third party can play an important role in these situations.
- **Scenario planning:** Scenario planning provides a structured and powerful tool to think about the future and challenges, especially where there are large uncertainties such as changes to natural systems (e.g. water and climate), changes in rules or an adjustment of goals (e.g. livelihood goals); and can be based on existing data, modelled, or a combination of both. Scenarios work best when elicited from in-country partners or developed in conjunction with in-country partners rather than imposed.
- **Systems thinking and approaches:** Systems approaches to better integrate biophysical with social and economic information are highly valued by project partners, from design through all stages of the project lifecycle to decision making. Systems approaches also promote participation from a broader range of stakeholders. In general most local research teams had limited experience of these approaches, including scenario planning, and Alliance activities significantly enhanced their capacity to understand and apply such systems tools.
- **Evaluation methods:** Assessments often take place in complex policy settings and systems where there are multiple actors. Accurately defining, measuring and attributing impacts is vital to describing and communicating the success of investments. The use of mixed methods approaches, and better understanding of which approaches work best under certain conditions, will improve the quality of impact evaluation studies and the articulation of impact. Also, the timely return of results to project research teams and partners is important to maintain the salience of results.

Steps required to maintain the Impact Pathway

Our recommendations are to:

- Undertake further study on the viability of the options identified. This is to allow for the objective comparison of various proposed options, for example, through the use of economic, environmental, and social costs and benefits analysis.
- Extend the future water security assessment to the greater MAMMINASATA region. The project has assessed future water supply security for Makassar City only. Given the common dependency of the various municipalities in MAMMINASATA on the river supply systems, an extension of the study to the MAMMINASATA region would facilitate greater water security for the city and broader region. It would also allow for an integrated water resources analysis that would address some of the knowledge gaps across catchments and administrative (municipality) boundaries.
- Undertake climate change impacts assessment on other sectors. The project focussed on the urban water sector. There is still a need to explore impacts on other sectors due to the inter-relationship between those sectors (i.e. water, food and energy). Outputs from the regional climate simulations provided by this project are available to support such studies.
- Collect, store and share data strategically. The project has found that data on the status of the environment, particularly on the ground water resources and extractions, is currently limited. This data is required to enable continuous monitoring and assessment of water supply (surface and ground water) sustainability. There is a need to strategically identify knowledge and/or necessary data for such a purpose, and then to undertake continuous data collection. Ensuring that required environmental data is strategically collected, stored and shared across urban decision-makers would support sustainable decision-making based on the best available data.
- Analyse wastewater and stormwater generation and impacts. Such analyses are essential. Experience has shown that successful adaptation must consider many components (water supply, stormwater and wastewater) in the urban water cycle.
- Undertake community campaigns to raise awareness of sustainability and climate adaptation across the wider community. Experience suggests that integrated water management solutions using a combination of community awareness and participation, and technology would provide sustainable solutions rather than reliance on technological solutions alone.

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