Report

External Review

Sino-Swiss cooperation project: *Rehabilitation and management strategy for over-pumped aquifers under a changing climate* (7F-09047.01)

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February 2018

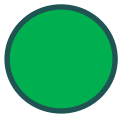
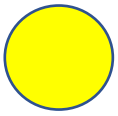
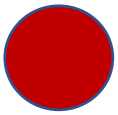
Summary: *Strong achievement on objectives, particularly in linking groundwater management measures with an evolving understanding of water resource conditions, trends and patterns of use. The integration of these elements, conceptually and practically, has been key to project success.*

Overall review score - Green

An excellent project with capable and committed partners that has achieved its planned objectives during Phase 1, and is contributing towards its higher-level goal/purpose. In particular, the project has been successful in developing an integrated monitoring and modelling system, and in demonstrating how this can be linked with sustainable water resources management planning. In so doing, the project has demonstrated how the institutional and academic siloes that often separate research and evidence gathering from policy and practice can be overcome. As the project moves into a proposed second phase, focusing mainly on groundwater management in the North China Plain, the team will need develop a clear partnering and capacity-building plan for wider scale-up and sustainability.

The project has broad regional and international relevance – for those countries where water resources are already under stress, and for those where rapid supply-side investment is not being matched by parallel investment in the soft plumbing of accounting, rights and allocation. However, the transferability of approaches and tools should be approached with caution: what works in China, and what is politically and administratively feasible to do in China, may not be possible in many low and middle-income countries.

What the review score means

Review score	What it means
	Strong achievement in all areas. Stands out as a project/programme of good practice where SDC funds are making a significant and positive contribution.
	Satisfactory achievement in most areas, but partial achievement in others. An area where SDC funds are making a positive contribution, but could do more.
	Unsatisfactory achievement in most areas, with some positive elements. Improvements are required for SDC funding to make a positive contribution.
	Poor achievement across most areas, with urgent remedial action required in some. SDC funds currently failing to make a positive contribution.

About the review

In November 2017 the Swiss Agency for Development and Cooperation (SDC) commissioned a mid-term review of the project *Groundwater Rehabilitation under a Changing Climate*. The review was led by Mr Roger Calow from the UK's Overseas Development Institute (ODI), with support from Prof Yang Dawen from Tsinghua University, and Prof Tang Kewang from the China Institute of Water Resources and Hydropower Research. The review included interviews with project staff, a desk review of project documents, an in-country field programme and a debrief with SDC staff in Bern, Switzerland.

The views expressed in this report are those of the review team only.

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Acronyms and abbreviations

CAREERI	Cold and Arid Regions Environmental and Engineering Research Institute (under CAS)
CAS	Chinese Academy of Sciences
CCP	Chinese Communist Party
CCT	Conditional cash transfer
CIGEM	China Institute of Geo-Environmental Monitoring (under MLR)
CNY	Chinese Yuan (currency)
DAC	Development Assistance Committee (of OECD)
DETEC	Swiss Federal Institute of the Environment, Transport, Energy and Communication
DFID	Department for International Development (UK Government)
ET	Evapotranspiration
ETHZ	Swiss Federal Institute of Technology
GEF	Global Environment Facility
GIWP	General Institute of Water Resources and Hydropower Planning Design (under MWR)
GW-MATE	Groundwater Management Advisory Team (World Bank)
ID	Irrigation district
MLR	Ministry of Land and Resources (Government of China)
MOST	Ministry of Science and Technology (Government of China)
MWR	Ministry of Water Resources (Government of China)
ODI	Overseas Development Institute
OECD	Organisation for Economic Cooperation and Development
SDC	Swiss Agency for Development and Cooperation
SDG	Sustainable Development Goal
SSA	Sub-Saharan Africa
WAB	Water Affairs Bureau
WRD	Water Resources Department

1. Review objectives and approach

1.1 Robust, independent evaluation of development programmes provide information about what works, what does not, and why. This serves two broad objectives: to improve the programme or intervention; and to hold the funding agency (and partner(s)) accountable for results.

1.2 Against this background, the Swiss Agency for Development and Cooperation (SDC) commissioned a mid-term review of the project, *Groundwater Rehabilitation under a Changing Climate*, hereafter termed the Groundwater Management Project (GWP). The project is jointly funded by SDC and the Chinese government under a 2009 Memorandum of Understanding.[1]

1.3 A three-person review team was assembled by SDC in December 2017. The team was led by Mr Roger Calow from the UK's Overseas Development Institute (ODI), with support from Prof Yang Dawen from Tsinghua University, and Prof Tang Kewang from the China Institute of Water Resources and Hydropower Research. Team members have different areas of expertise; collectively they cover water policy, economics and governance, and surface and groundwater assessment, monitoring and modelling. To ensue impartiality and independence, team members had no prior or current connection with the GWP.

1.4 The terms of reference for the review were drawn up by SDC, with review criteria following standard DAC[2] practice for assessing the performance of projects and programmes. Key questions therefore focused on project (1) relevance; (2) effectiveness; (3) efficiency; (4) impact; and (5) sustainability. In addition, the review team completed a DAC-based Assessment Grid provided by SDC, submitted as a separate document.

1.5 The review was conducted between December 2017 and February 2018, and included interviews with project staff prior to the country visit, a desk review of project documents, an in-country field programme, and a debrief with SDC staff in Bern, Switzerland. The China field programme (8 – 19 January 2018) was coordinated by SDC-Beijing, and included meetings with key project stakeholders in Beijing, and visits to the two pilot sites in Handan and Heihe (see below). The full programme is attached as Annex A. Annex B lists the

1 Between the Swiss Federal Department of the Environment, Transport, Energy and Communications (DETEC) and the Ministry of Water Resources (MWR) of the People's Republic of China.
2 The Development Assistance Committee (DAC) of the Organisation for Economic Cooperation and Development (OECD) set out five criteria for evaluating international development activities in 1991. Since then they have been widely used by for aid evaluation by most bilateral and multilateral donor agencies, as well as by international nongovernmental organisations.

organisations and people met during the 10-day visit. Annex C lists the project documents provided by SDC and reviewed by the team prior to the country visit.

2. Project overview

2.1 The original project proposal (the Credit Proposal, dated 2014) provides a comprehensive overview of the project, and includes a logical framework, work plans and milestone markers and budget, as well as sections describing need/demand for the work, key stakeholders, risk management and monitoring and steering arrangements. This is a reasonably robust document, although it does not include 'theory of change' analysis common to most projects now, or a justification for the project based on a review of related work (government and donor funded) in this area. Project design issues are picked up again in Section 3.

2.2 The overall **goal** of the project is '*To have the adaptation capacity to climate change strengthened by supporting better groundwater management through real-time monitoring, modelling and controlling in areas under water stress*'. The wording here is somewhat confusing, as the statement mixes up a goal (adaptive capacity strengthened) with a purpose (improved groundwater management) and an objective (real-time monitoring etc). In other words, we are doing *this* by doing *this* by doing *this* - three levels. There is also a sense that the climate change angle is misplaced, since (rightly) the project does not centre on long term climate scenarios and their implications for water availability and services.

2.3 The expected **outcomes** or objectives of the project are clearer and listed as follows

- Outcome 1: Providing the data and information base for real time water allocation.
- Outcome 2: Developing and implementing an integrated real-time monitoring, modelling and controlling system to prevent groundwater depletion and build up adaptation capacity to climate.
- Outcome 3: Policy options are elaborated through dialogues with the stakeholders and implemented by the local authorities.
- Outcome 4: Improved knowledge of using real-time monitoring, modelling and controlling system to prevent groundwater depletion for arid regions in developing countries.

2.4 The achievement of project objectives across the two pilot sites (see below) is staggered, and linked to Phase 1 and Phase 2 funding. Hence for Heihe, and referencing the Credit Proposal, '*outcomes will be fully achieved and made available for Handan*'. For Handan, on the other hand, '*…the data information base will be available, monitoring & modelling in elaboration, and policy options about to be prepared*'. All work in Handan (i.e. achievement of all objectives) will be completed during the proposed Phase 2.

2.5 The project was launched in 2014 with an opening phase running from March 2014 – December 2014, followed by the main Phase 1 from Dec. 2014 to March 2018. A second phase scheduled for April 2018 - December 2020 is now under consideration, with a primary focus on the North China Plain.

2.6 The project is carried out in two pilot regions: Luotuocheng (Gaotai County) in the middle stream of Heihe river basin in northwest Gansu Province, and Guantao County, Hebei Province, in the North China Plain. The review team understands that MWR's principal interest is in addressing groundwater over-exploitation in the North China Plain, but that the piloting of a monitoring, modelling and control system in Heihe was agreed as a necessary test-bed.

2.7 In terms of institutional arrangements, the project is executed under the supervision of SDC and MWR in China, both represented in the Project Steering Committee. The project is led by the Swiss Federal Institute of Technology (ETHZ), in partnership with Hydrosolutions Ltd and Geo-Praevent Ltd. The credit proposal includes a section on organisational arrangements.

2.8 On the Chinese side, arrangements differ somewhat between the pilot areas. For Handan, the General Institute of Water Resources and Hydropower Planning Design (GIWP) under MWR oversees project implementation. In the Heihe pilot region, however, it is the Cold and Arid Regions Environmental and Engineering Research Institute (CAREERI) under the Chinese Academy of Sciences (CAS) that leads. In addition, the China Institute of Geo-Environmental Monitoring (CIGEM) under the Ministry of Land and Resources (MLR) provides significant support, offering hydrogeological assessment information that underpins modelling, and a link to ongoing (country-wide) groundwater monitoring.

2.9 The Credit Proposal does not provide a breakdown of staff commitments, so it is impossible to tell who, exactly, is working on the project and the commitments they are making – or should make. In addition, the review team do not have access to partner budgets

3. Review findings

In this section, we look at how the project has performed against the DAC metrics of relevance (Section 3.1), efficiency (3.2), effectiveness (3.3), impact (3.4) and sustainability (3.5). Specific questions under these criteria are taken from the review terms of reference.

3.1. Relevance

Here we examine the extent to which the project aligns with the priorities and policies of the Chinese government, and whether the overall project design is consistent with stated objectives and intended impacts. In addition, we reflect on the project's wider international relevance.

Is the project relevant to China's national strategy and policies?

3.1.1 China's national strategies and policies now prioritise environmentally sustainable development, or what the Chinese Communist Party (CCP) calls an 'ecological civilization'.[3] Under this broad banner, the recent 19th People's Party Congress reaffirmed the CCP's commitment to green growth and natural resource management monitoring and control, with the possibility of major institutional reform to follow.[4] In short, there is a recognition across government that environmental degradation poses a threat to China's future development, and arguably the legitimacy of the Party-State.

3.1.2 Within the water sector, it is clear that tackling problems of water resources degradation is now the top priority at all levels of water administration. Under the Three Red Lines Policy (2010 – 2030), national water withdrawal, efficiency and quality targets are cascaded down to lower levels of government through a mix of hard and soft targets.[5] There are some tricky trade-offs involved. Government water resource departments (WRDs - provincial) and water affairs bureaus (WABs - prefecture, county) are all grappling with the need to cut water withdrawals whilst safeguarding farm incomes and national food production.

3.1.3 Against this background, we see something of a 'carrot and stick' approach to reform: the introduction of quota-based water rights, water pricing and drilling controls (via protection zoning), alongside subsidies for new irrigation technologies and, in some cases, direct cash payments to farmers for set-aside (see Box 1). The political space for reform will probably widen as rural and urban economies converge further and rural livelihoods diversify. In particular, the consolidation of land holdings, and further

[3] A phrase first coined by former president Hu Jintao in 2012.

[4] Report of Xi Jinping to the 19th Congress of the CCP (2017).

[5] Meaningful reform and enforcement of regulations is often achieved more through China's system of cadre evaluation – the system for top-down bureaucratic personnel assessment – than through the country's notoriously weak environmental law regime.

reductions in the numbers of rural people that depend on farm incomes, should make water (and agricultural) reforms easier to introduce over the coming decades.

3.1.4 Our discussions with MWR, in particular, confirmed the priority now attached to addressing groundwater over-exploitation in the North China Plain, where symptoms include falling water levels (and higher pumping costs), land subsidence (and associated reductions in aquifer storage and infrastructure damage), and saline intrusion in coastal areas (affecting water quality). The problem has been many decades in the making, and is well documented.

3.1.5 We note that while the project is certainly not unique in attempting to characterise and address such problems, the integration of different components (see 3.2 below) does represent something of a new approach for local partners used to working in academic or practitioner siloes. Indeed MWR were keen to point out how the project was helping them move from a '*broad-brush, uninformed approach to reform*', to a much more '*evidence-based approach*', drawing on '*international experience in environmental protection and management that remains new to China*'.[6]

3.1.6 We note that the project has mapped policies and regulations, national to local. A useful exercise (see Annual Reports). These should be kept under review and updated as necessary. The team also noted strong engagement on design and implementation of local policies/regulations: Handan (energy consumption as a proxy for water withdrawals); Heihe (public-private

Box 1: Groundwater control programmes

In 2008, the Government of China proposed a programme called 'Groundwater overdraft control planning for central and eastern, south to north water diversion areas'. In view of difficulties experienced in managing groundwater withdrawals in agricultural areas, in 2014 central government earmarked CNY 20B for pilot reforms in Hebei Province. Initially covering 49 counties in Hebei (including Guantao), the programme ('Integrated Project on Groundwater Rehabilitation in Hebei') now covers 161 counties, and involves the Ministries of Finance, Agriculture, Land & Resources and Water. From 2017 onwards, the programme is being extended to Shandong, Henan and Shanxi provinces – the next-most groundwater stressed areas.

The programme includes subsidies for new irrigation technologies, metering and price reform, groundwater monitoring and, interestingly, cash payments to farmers if they stop growing winter wheat (payment of CNY 500/mu). Verification is based on remote-sensing data. Payments are made directly by central government into farmers' bank accounts to avoid appropriation by mid-level government.

Direct cash payments are controversial – 'payment for doing nothing' as one senior official described it. However, conditional cash transfers (CCTs) of this kind are widely used in social protection programmes internationally, and have been accompanied by systematic efforts to measure their effectiveness and understand their broader impact on household poverty and behaviour. Results have been broadly positive.

Source: discussions with Handan and Guantao WABs, and with academics at Tsinghua and Beijing universities.

[6] Comments from Dr Hou Jie (MWR-GIWP) and Mr Qi Bingqiang (MWR-Division of Water Resources).

partnership, water pricing, quota-based management). Project impact is discussed further in Section 3.4 below.

Are the activities and outputs of the project consistent with the overall goal and the attainment of the objectives, and with intended impacts and effects?

And closely related to this and therefore combined:

Is the overall design of the programme adequate to achieve its goal & objectives?

3.1.7 To date, the review team conclude that overall programme design, and the choice and sequencing of activities in support of project objectives, has been broadly fit for purpose, despite some misgivings about the original Credit Proposal. These relate to: (1) ambiguity over the project goal; (2) the lack of any systemic review of published or grey literature on past/current experience in tacking groundwater degradation in China; (3) a rather weak (and one-off) attempt at stakeholder analysis[7] and needs assessment that lumps 'national and sub-national authorities' together as one homogeneous target group; (4) the lack of any 'theory of change' analysis now regarded as mandatory in projects of this size and ambition; and (5) a sense (from the logframe at least) that new tools and approaches will be 'handed over' to 'relevant' authorities as somewhat passive recipients of Swiss expertise.[8]

3.1.8 The review team also note that while policy engagement is a key feature of the project (Objective 3), none of the Swiss partners appear to have any recognised expertise in this area. We do note, however, that the project is drawing on individual policy expertise from Dr He Pan at Hydrosolutions. Does this matter? In view of the clear policy dialogue and influence the project has had over a relatively short period of time, probably not. Nonetheless, the review team have some concerns over policy dialogue, and the apparent emphasis (from government at least) on differential water pricing, and the use of quota-based water rights as a means to levy prices rather than cap withdrawals directly. Our dialogue with MWR was illuminating in this regard: pricing is regarded as the key instrument for demand management, with some surprise that internationally, systems of volumetric allocation rather than prices are used to balance demand and supply, and ensure the needs of other sectors are met.[9]

3.1.9 The review team note that the choice of partners has been determined to some extent by the need to begin work in Heihe, and then transfer experience to Handan. In Heihe, it is clear that local partnerships have worked very well, with CAREERI (and Lanzhou University) in particular offering high-level technical expertise. In Handan also, partners are clearly working well together, with strong engagement from Handan and Guantao WABs, CIGEM and Beijing-based GIWP, although GIWP probably lack the time and manpower to engage as much as they might like. A key question for

[7] Typically, stakeholder analysis would not be conducted as a one-off exercise at the beginning of a project but would continue throughout – to help identify and monitor (for example) stakeholders' alignment with and interest in project outcomes.

[8] So under risks & assumptions in the logframe, we have statements such as 'Suitable personnel are found to operate the system' (Output 2.3). This rather suggests that systems/tools are developed and then end users are sought

[9] This is not to say that prices are not used to signal scarcity. Rather systems commentators often assume demonstrate price-limited demand are actually limited by quotas. Even in those countries facing extreme water stress (Jordan, Israel, Morocco, Australia), it is volumetric allocations (quotas) rather than pricing that balance demand and supply. See for example FAO's *Water charging in irrigated agriculture: An analysis of international experience* (2004): http://www.fao.org/3/a-y5690e.pdf .

future engagement in Handan, therefore, concerns institutional arrangements for long-term ownership and adaptation of systems. Specifically, which agency or organisation(s) has the capacity (and authority) to maintain hardware and software, and provide technical support for practitioners in county-level WABs (see below).

3.1.10 The review team were reassured to hear that ETHZ and Hydrosolutions are engaged in an ongoing dialogue with Chinese partners on this issue. Specifically, the technical *and* institutional vision for the monitoring-modelling-controlling system in Guantao and surrounding areas. It appears that MWR-GIWP wish to take on the data assembly, modelling and delivery (output of results) role, with support from CIGEM.[10]

3.1.11 A related question, and relevant to the sustainability-scale question below, concerns the role of provincial-level Water Resource Departments (WRDs) in Lanzhou (Gansu) and Shijiazhuang (Hebei). While both have been peripherally engaged to date (as data providers and participants in workshops & study tours), deeper engagement may be needed as the project seeks to sustain and scale early gains.

Does the project have regional or global relevance in knowledge sharing for countries under similar water stress?

3.1.12 In short, yes, but with some caveats. Entrenched problems of groundwater degradation have been well documented in south and central Asia, and across the Middle East and North Africa.[11] Less well documented are the emerging symptoms of groundwater over-exploitation and miss-allocation in Sub-Saharan Africa (SSA), where groundwater development typically provides the only pathway for achieving Sustainable Development Goal (SDG) 6[12], and supporting a range of other goals. This is because accelerating investment in the hard infrastructure of water pumping, storage and conveyance is not being matched by parallel investment in the 'soft plumbing' of water accounting, water rights and management. A key question for these rapidly growing economies is whether they will repeat the same mistakes China has made in privileging supply-side development at the expense of environmental sustainability.[13]

3.1.13 From a donor perspective, we also note that it will become increasingly difficult to justify China-only funding to sceptical domestic audiences in view of China's growing wealth. Hence donors such as DFID have abandoned bi-lateral technical assistance, and are instead looking to bring China into wider regional/international dialogues on climate change, transboundary water management and so on. In view of the general good-will and political capital banked under the project to date, we see scope for raising the project's international ambitions under Outcome 4 (see below).

[10] Data input includes head observations, pumping rates, rainfall and surface water input. Outputs include maps of head and head change distribution, a map showing divergence with sustainability thresholds, and suggested changes in pumping and cropping. (Prof Kinzelbach, personal communication).

[11] See for example, Giordano, M. (2009). Global Groundwater? Issus and Solutions. *Annual Review of Environment and Resources*. 2009; 34: 152-178.

[12] Sustainable Development Goal (SDG) 6: Ensure availability and sustainable management of water and sanitation for all.

[13] See Calow et al (in press). The environmental dimensions of universal access to safe water. Chapter 7 in: *Achieving Equality in Water and Sanitation Service Delivery*, edited by Tom Slaymaker (UNICEF) and Oliver Cummings (LSHTM). Routledge.

3.1.14 What of the caveats? China's commitment to and progress in tacking environmental problems is impressive, and helped significantly by the breadth and depth of its administrative apparatus. Most developing countries lack this. Even in middle-income India, the government has struggled to tame 'boom and bust' groundwater economies, where groundwater is effectively self-supplied by millions of small farmers beyond the (easy) reach of the state. For these reasons, some caution is merited in assuming ready transferability of project approaches to other countries.

3.1.15 Nonetheless, what could others governments (and donor programmes) learn from this project? In broad terms, China's experience provides a reminder of the costs of inaction: how left unchecked, environmental issues can quickly spiral into social, economic and political ones. More recently, China's prioritisation of environmental concerns has shown how it is possible to move from 'nirvana' concepts (ecological civilization, integrated management) to action on the ground. While many governments (and donors) remain preoccupied with principles and creating the right framework ('nexus') for better water management, China's engagement with the nuts and bolts issues of rewards and incentives, clarifying rights and responsibilities and, above all, getting results, shows how pragmatic management begins with defined problems and objectives, and then looks at practical ways for addressing them.

3.1.16 China can also learn from other countries. In India, for example, pump sets in some areas have been equipped with solar panels in pilots led by the International Water Management Institute (IWMI); farmers can either use the electricity generated to pump water for crops, or sell electricity back to the grid at an advantageous price. They cannot do both. Farmers are confronted with an opportunity cost, and government is relieved of the burden of trying to monitor and directly control water withdrawals.[14]

3.1.17 In view of the above, the review team proposes a more ambitious approach to Outcome 4 that goes beyond workshops, study tours and conferences, and seeks to leverage Chinese funding for much stronger international engagement. This need not be restricted to obviously water-stressed, arid areas, but could also be applied to areas with emerging symptoms of degradation and weak governance.

3.2. Efficiency

In this section we assess project outputs in relation to inputs. This includes a broad assessment of cost-effectiveness, the performance of partnership arrangements and project management, and synergies (or duplication) with other water management initiatives.

Were the objectives achieved and in a cost-effective way?

3.2.1 The review team conclude that anticipated objectives have been met, though all could be strengthened and scaled further during Phase 2. In the judgement of the team, we also conclude that they have been achieved in a cost-effective way. This judgement is based on our experience of leading, or participating in, projects of similar size and ambition which often fail to generate (often unrealistic) policy change or influence ways of working.

14 For a quick overview of how this has worked in the Indian state of Gujarat, see this blog.

3.2.2 It is more difficult to judge whether individual project components, led by different partners, have been delivered cost-effectively. For example, the credit proposal lacks a convincing discussion on task allocation and resourcing, and specifically the justification for sustained funding of Swiss consultants in leading and doing the heavy lifting on system/model development. One could argue, for example, that a more hands-off supporting/advisory role with local partners would have been more cost-effective.

3.2.3 Pushing this point is perhaps a little unfair: Chinese partners clearly want what the consultants are delivering; and the proposal hints at something uniquely 'Swiss' about the expertise on offer. On balance, the review team conclude that the integration of water resource assessment, monitoring, modelling and controlling probably justifies spend allocation to date; it would be difficult to see this happening without heavy and sustained engagement by Swiss partners. That said, funding objectives (support for local ownership and capacity building) may need to shift in Phase 2.

3.2.4 The review team do not have access to partner budgets or information on financial reporting, but understand that reporting to SDC includes a breakdown of staff spend verified with timesheets.

3.2.5 The review team assume that SDC have confirmed that all software being developed by Swiss partners is free and open-source, and does not tie local partners in to long-term commercial arrangements with Geo-Praevent Ltd or Hydrosolutions Ltd.

3.2.6 The introduction of a Groundwater Game in Handan is an interesting initiative, and local WABs are clearly supportive. Bringing farmers and WAB staff closer together is a good idea, especially if the game allows for a more neutral discussion of shared (inter-connected) problems and solutions. Games such as this have been developed by others, however, so high spend on a bespoke game would need to be justified

Is the project working with the best arrangement of partners?

How do you assess the performance and the capacity of the partners and cooperation between Swiss and Chinese teams, as well as project management in general?

3.2.7 As noted above, the project did not begin with a blank institutional canvass. The configuration of partners established in the preparatory phase, and maintained through Phase 1, has been dictated to some extent by the need to work in two (distant) pilot areas, and MWR's reluctance or inability to involve itself directly in Heihe via GIWP.

3.2.8 In our judgement, the arrangement of partners has worked very well in Phase 1, and the review team were also impressed with the level of engagement with prefecture and county-level WABs; many WAB staff took an active and informed part in our discussions in the two areas, and were at pains to point out how much they had both learned and put into practice.

3.2.9 All partners reported an excellent spirit of cooperation, knowledge exchange and data sharing, although the latter has clearly been hampered by local protocols governing data disclosure and storage. The project has adapted successfully to these constraints, albeit at some cost in terms of (for example)

re-digitising data from the electricity department. In the reviewers' opinion, the project has addressed such problems in a pragmatic and flexible manner.

3.2.10 Looking at the performance and capacity of individual partners, the review team are positive: specified outputs and outcomes are robust, and have been achieved on time and to budget (as far as we can ascertain). In Heihe, in particular, Swiss partners have clearly formed a strong technical partnership with CAREERI, Lanzhou University and CIGEM covering all aspects of data assimilation, surface-groundwater modelling, allocation optimisation and system integration, working closely with practitioners in Zhangye and Gaotai WABs, and those in Luotuocheng Irrigation District (under Gaotai WAB). We also heard how modelling has included climate scenarios spanning 10 – 30 years.

3.2.11 Based on successful experience in Heihe, Phase 2 of the project in Handan will clearly require strong technical backstopping. As noted above, a key question for future engagement concerns which organisation is able to 'own', understand and adapt/update systems, and provide ongoing support to practitioners in WABs beyond the project end date.

To what extent does the project build on the results of previous groundwater management initiatives in China?

3.2.12 Water resource authorities in China have been grappling with the problem of groundwater degradation for over three decades. The government's traditional approach to addressing over-exploitation could be characterised as the 'technical fix': promoting water efficiency through modern irrigation equipment, often with heavy subsidy. Paradoxically, such efforts often make the problem worse. This is because the savings liberated by drip and sprinkler systems (for example) end up getting reused to further expand the irrigated area or intensify production. This can happen when water rights entitle farmers to withdraw a certain volume of water, and when savings from increased 'efficiency' are not translated into permanent reductions in well withdrawal rights. Moreover, the 'saved' water may never have been lost in the first place if it returned to groundwater via return flows (seepage) for reuse by others, or to sustain environmental services/assets (e.g. base flow in rivers, wetlands etc).

3.2.13 The complex arithmetic of water accounting and water conservation is becoming better understood in China, though remains patchy. Project partners – certainly on the Swiss side – are familiar with the arguments, even if some of the language used in reporting sometimes fails to convey this. For example, use of the word consumption when water abstraction or withdrawals are referred to is unhelpful.

3.2.14 The need to focus on the consumptive use of water, and on linking water rights with real savings, has underpinned much of the World Bank's water resources work with MWR over the last two decades. Indeed Guantao County was a pilot area for the Bank under a GEF-funded initiative that sought to combine a basic understanding of resource conditions with an evapotranspiration (ET) - based (via remote sensing) monitoring and control system. The system has subsequently been implemented in Xinjiang under

the Bank's USD 100M 'Xinjiang-Turpan Water Conservation Project' with reportedly positive results.[15]

3.2.15 The review team queried the need for a follow-up (and somewhat different) groundwater management pilot in Guantao, given that both MWR and the Bank report the ET-based pilot a 'success'. Our discussions with the MWR suggested that while the ET initiative had been useful in illustrating key concepts, it had proved 'too difficult' to operationalise.

3.2.16 Our discussions with ETHZ also hinted at the practical difficulties associated with ET-based monitoring and control systems, and the challenge of *accurate* measurement in complex environments. We do note, however, that accounting systems based on consumptive use (rather than diversions) take on a critical advantage when water trading is promoted. This is because users cannot trade the return flows that others may depend on if accounting is based on consumption.[16]

3.2.17 At the same time, the Chinese government has also funded its own groundwater management projects, aimed at both resource assessment and the piloting of water rights and pricing reforms. Work on regional groundwater assessment, funded under the government's National Basic Research Programme (973), is described briefly in Box 2 below. ETHZ and Hydrosolutions are familiar with the study, but note, rightly, that it does not provide the resolution needed for county-based resource assessment and control planning. Hence the review team do not see any obvious duplication of effort. Similarly with the management programme outlined in Box 1, we see the project informing and dovetailing with existing initiatives, for example on groundwater monitoring (with CIGEM) and in policy engagement (e.g. proxy approaches to water abstraction estimation and

Box 2: Related projects – groundwater assessment for the North China Plain

Between 2010 and 2015, the National Basic Research Programme (973) of China funded the project "Evolution Mechanism and Management of Groundwater in North China".

This project evaluated the groundwater flowing field and its response to human activities over the past 50 years in the North China Plain, and investigated the change of water flowing parameters and the structure of aquifers. It also studied ground subsidence, the risk of saline intrusion and the composition of deep groundwater. A numerical groundwater flow model was developed based on renewed data between 2001 and 2010 and improved groundwater modelling techniques.

Based on this model, this project estimated renewable water volumes, sustainable yields (termed groundwater resource carrying capacities – GRCC) and the main factors affecting GRCC. This project also suggested very broad-brush solutions for the management of the groundwater resources in the North China Plain based on modelling results.

Source: Shi Jian-sheng, Li Guo-min, et al (2014). Evolution Mechanism and Control of Groundwater in the North China Plain. Acta Geoscientica Sinica, Vol.35 No.5: 527-534. (In Chinese)

15 See the World Bank's Implementation Completion and Results Report (IBRD-79340) here. For a more detailed discussion of how the system works, see this report and summary blog.

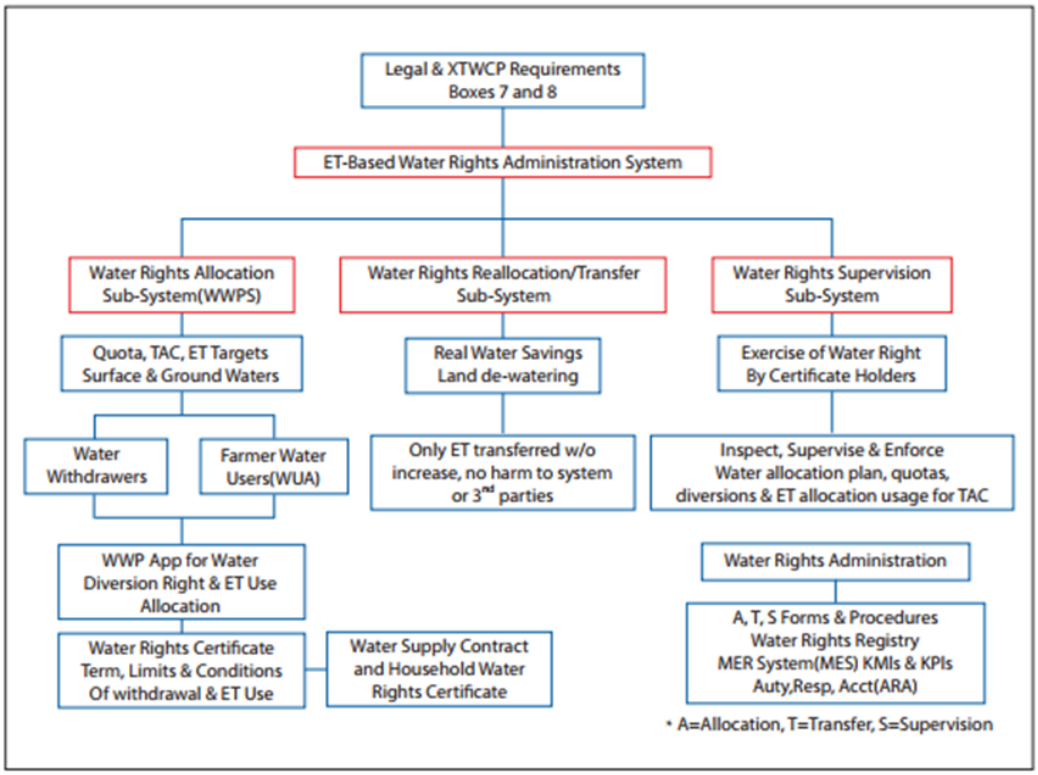
16 This importance is well understood in the western USA and Australia where all transactions involving water rights are embedded in a legal and administrative framework that carefully regulates and accounts for third party effects.

control that can be scaled-up in Hebei, and potentially scaled-out to other regions).

3.2.18 Government-sponsored pilots have also looked at electricity price reform as a means of limiting withdrawals without recourse to burdensome water monitoring. In the Taocheng district of Hebei, for example, the 'Increase price and provide subsidy' initiative, running since 2005, levies additional pumping charges on farmers (volumetric proxy) while providing rebates based on land area. The difference between the fee and the return is treated as an incentive for farmers to reduce pumping.[17]

3.2.19 We conclude that while at least some of these initiatives are known to project partners, and have helped underpin work in the pilot sites (at least in Guantao), the lack of any systemic review of published or grey literature on past/current experience should be addressed in Phase 2. This would provide a useful working document in its own right, and can also help inform efforts to share experience and findings with other initiatives.

Figure 1: Framework for the ET-based water rights administration system in Turpan, Xinjiang



Source: World Bank (2014).

3.3. Effectiveness

Here we assess the extent to which the project has met its objectives, looking specifically at the quality and delivery of outputs, and areas for potential improvement.

[17] Wang, J., Zhang, L. and Huang, J. (2016). How could we realise a win-win strategy on irrigation price policy? Evaluation of a pilot reform project in Hebei Province, China. *Journal of Hydrology* 539 (2016) 379-391.

What are the major results/findings/achievements generated by the project, and have intended outcomes/outputs been achieved?

3.3.1 The Credit Proposal links achievement of project objectives to Phase 1 and Phase 2 funding. Hence for Heihe, '*outcomes will be fully achieved and made available for Handan*'. For Handan, on the other hand, '*…the data information base will be available, monitoring & modelling in elaboration, and policy options about to be prepared'*. All work in Handan (i.e. achievement of all objectives) will be completed during Phase 2.

3.3.2 The review team conclude that project objectives have been met for Phase 1. Specifically, that objectives for Heihe have been (almost) fully achieved, that the 'information base' (if not all data – data collection and assimilation is an ongoing task) has been established for Handan, and that significant progress has been made with monitoring, modelling and the elaboration of policy options for Handan. Perhaps more than originally anticipated.

3.3.3 In Heihe, the review team discussed major findings and achievements with partner staff from CAREERI, Lanzhou University and CIGEM, and with government staff in Zhangye and Gaotai WABs, as well as irrigation district personnel in Luotuocheng. Zhangye WAB and its delegated (county) WABs and IDs have clearly been 'star performers' under the government's reform agenda, so project achievements here should perhaps be viewed in this light: this is fertile ground, and the roll-out of smart metering and preliminary price reform pre-dated GWP.

3.3.4 Nonetheless, the project has clearly done a great deal and enthused local staff – major achievements whatever the context. For example: in establishing a comprehensive and robust database and platform (demonstrated to the team); in developing and operationalising the monitoring module (surface and groundwater), including use of combined pumping-electricity meters; in developing further CAREERI's original groundwater model with fresh data and a new interface; and on policy engagement linked to water rights and pricing. This is not to say that all problems have been 'fixed'; water rights are still based on historical (unsustainable) crop calendars, for example. But it appears that WAB and ID decision-makers have the evidence, tools and confidence needed to make further progress, and apply lessons and approaches to other IDs and counties – something they said they would do.

3.3.5 One of the interesting features of the Heihe pilot has been the involvement of a private sector partner (Huafeng) in smart metering. In short, the cost of installing meters is shouldered by the company in return for a cut of the volumetric water resource fee (now tax) that users pay when they pump water. The margin the company takes is also sufficient to cover the costs of ongoing maintenance. While such an approach is innovative, and intuitively appealing to governments (and donors), it does carry risks. In particular, the creation of a link between water withdrawals and company profit and, without very close scrutiny of contracts, long-term deals that potentially generate monopoly profits. Central government's recent decision to cover the operator's costs, and the return of water taxes (previously fees) to central rather than local coffers, mitigates at least some of these risks.

3.3.6 While Heihe may have won plaudits for water pricing reform, the review team struggled to understand pricing objectives and structure. Specifically, the need to collect (for groundwater users) four separate charges, including electricity, and a sense that tiered water quotas were primarily vehicles for

fee collection rather than direct volumetric control. There may be a temptation with smart metering for authorities to over-complicate things (because they have the means), and lose sight of what, exactly, they are trying to do with quota and charging systems.

3.3.7 As a general rule, the simpler the better – certainly for farmers. That means quotas that cap withdrawals, volumetric pricing (discretionary, not essential) to curb the most profligate uses, and flat fees to raise money for channel maintenance, if applicable, all linked with easy-to-access subsidy or cash transfers to help farmers adapt. Simpler still, quotas combined with electricity tariff reform and rebates, as in Taocheng County (see previous). These comments also apply to the Handan dialogue on policy options.

3.3.8 In Handan, the project is on-track to meet the objectives set for Phase 2. The review team discussed major findings and achievements to date with GIWP, and with WAB staff in Handan and Guantao. The team also spent some time with a small group of farmers to better understand their views on groundwater conditions, groundwater control measures and the future of farming more generally. Again, the team were impressed by the commitment of WABs to 'get a grip' on the overdraft problem, and the progress the project has already made in supporting them.

3.3.9 The review team were impressed by the effort being invested in developing a robust groundwater model, the reconstruction of pumping records based on historical electricity consumption, the installation of new monitoring wells, the embryonic data platform, and the Irrigation Calculator. Above all, the team were impressed by the project's recognition that 'one size does not fit all': that somewhat different approaches are needed in Handan because of smaller land holdings, and smaller and more poorly equipped wells.

3.3.10 In this context, the decision to look to electricity consumption as a proxy for water withdrawals makes sense. Indeed this approach to monitoring water withdrawals on the North China Plain was proposed over a decade ago by members of the World Bank's GW-MATE team. We understand that after some initial reluctance on the part of WABs ('too unsophisticated'), a decision has now been taken to adopt this proxy approach *across* Hebei. This, we heard, is directly attributable to the project. To this end, the collaboration established with the local electricity department under the State Grid Corporation of China (the electricity utility) is a massive 'plus', even if data processing has proved burdensome. Cross-sectoral and cross-departmental coordination of this kind is a rarity - in China and elsewhere.

3.3.11 The review team are strongly supportive of efforts to combine the technical elements of the project with insights from the social sciences. We welcome, therefore, the project's engagement with a farm survey in Luotuocheng and the commissioning of a survey (with a gaming component) in Guantao. That said, we think the Guantao survey at least would have benefited from a clearer set of objectives, and a better understanding of the factors that incentivise or inhibit cooperative behaviours. The results reported[18] are neither surprising nor particularly illuminating in terms of refining management options, though the review team did not review the gaming element in detail. And while we welcome the fact that local students were involved in conducting the survey, we think design work could have been

[18] Handan Pilot Region Annual Report, April 2016 – March 2017.

done in-country, or at least planned with a local partner.

Critically assess the quality of the project outputs and activities, their relevance to project outcomes, and identify areas for improvement

3.3.12 Many of the comments above apply. In short, the review team consider that the outputs are of a high quality, and have been directly relevant in achieving project objectives.

3.3.13 The review team were particularly keen to assess the robustness of the modelling work, and the robustness of the data the models depend on. We concluded that, while the work in Handan is clearly 'work in progress', in both pilots steps have been taken (or are being taken) to incorporate necessary parameters (aquifer properties – porosity, permeability etc), to calibrate and validate models using the best available historical (cleaned) data plus 'new' real-time data, and to run sensitivity analyses. We also note the effort made to calibrate electricity consumption with water withdrawals (Handan) using pumping tests, and how this task was carried out with the involvement of the provincial WRD and students from a local university.

3.3.14 Although the review team concluded that individual project components – essentially project outputs – are not breaking new ground technically, the *integration* of monitoring and modelling, and the link with management options, is innovative. Local partners in each area clearly regarded the approach as new to China, while MWR highlighted the importance of establishing a consistent relationship between resource estimates and permitted abstraction.

3.3.15 The team's only concerns relate to points highlighted previously. Specifically:

- The need to identify which organisation has the capacity and remit to not just use the tools, but to understand and adapt the underpinning models as more data become available, and provide the technical backstopping for WABs necessary for scale-up.
- The need to shift the policy dialogue away from pricing structures (bands, starting points) towards rights themselves, and the need to link 'sticks' (quotas) with 'carrots' (subsidy, cash transfers etc).
- The need to consider what investigative work can usefully be carried out by social science teams, particularly in terms of exploring farmers' attitudes towards quota-based management and confidence-building measures around compliance.
- Outreach to other projects: this project is piloting a novel approach and suite of tools, but it is not happening in *isolation*. The project could do more to engage and share experience with other projects/programmes, including those funded by the World Bank and, independently, by the Chinese government.

3.4. Impact

In this section we look at the changes in policy and practice that can be reasonably attributed to the project, within the pilot areas and beyond. This also includes an assessment of the project's communication and knowledge management strategy.

Which learning or changes have occurred as a result of the project – within the immediate project areas?

3.4.1 The project team would be the first to admit that in in both pilot areas, sustainable management of water resources remains an aspiration. In Heihe, for example, water withdrawal quotas – if applied – are based on estimations of water need (historical cropping patterns) rather than water availability. And in Guantao, Handan, although rights are theoretically defined under the Three Red Lines Policy (see Section 3.1 above), quotas for fee collection are based on crop needs. As noted above, however, local partners and MWR-GIWP are now clear on the direction and destination of travel, based on an understanding of resource conditions, patterns/levels of water withdrawal, water consumption, return flows, climatic conditions and surface water imports. In other words, they now have the *evidence* needed to inform regulatory and pricing reforms that will help balance demand and supply, even if implementation has to proceed slowly and incrementally.

3.4.2 In the simpler, longer-running and more advanced Heihe pilot, officials were keen to point out how their understanding of surface-groundwater interactions had improved; they were no longer treating surface and groundwater as separate systems. This understanding will help ensure that downstream river flows are maintained – politically symbolic. Local officials were also able to demonstrate how the integrated monitoring, modelling and control system works in *practice* within the ID; an achievement they were clearly proud of. There is also some evidence indicating that control measures have started to curb water withdrawals, though not yet to sustainable levels.

3.4.3 In the more complex, early-stage Handan pilot, local officials were equally enthusiastic about the potential for system integration, even if implementation is work-in-progress. Importantly, much of the background work (experiments with smart meters, pump testing, installation of new monitoring wells etc) has clearly been a collaborative effort. The decision by local officials to monitor electricity consumption as a proxy for water withdrawals was attributed to the project. This offers a practical and pragmatic solution to the monitoring problem, and the cooperation achieved with the local electricity department is a significant achievement.

What impact has the project had beyond the pilot areas, e.g. on wider policy change and practice for groundwater management in water-stressed areas?

3.4.4 In terms of direct policy influence, perhaps the most significant impact of the project is occurring via policy formulation within MWR. Specifically, the drafting by MWR-GIWP of China's first *groundwater-specific* regulation, '*inspired and informed*' by the project according to GIWP.[19] The regulation has been submitted to the State Council for review and approval, expected by the end of 2018. The regulation will apply nationwide.

3.4.5 The regulation contains eight chapters. According to GIWP these deal with: (1) general issues; (2) evaluation and planning; (3) protection and exploitation control; (4) addressing over-exploitation; (5) pollution prevention and control; (6) supervision and monitoring; (7) legal liability; and (8) supplementary provisions. The regulation was not available for

[19] Dr Chen Fei (GIWP), personal communication 10 February 2018.

review.

3.4.6 As noted above, the decision by Hebei WRD to follow Guantao's example and monitor water withdrawals indirectly through electricity metering is a significant impact, and one which is more readily attributed to the project. MWR-GIWP noted that this proxy approach could be applied to other groundwater-dependent northern provinces. Potentially, the approach might obviate the need to collect separate electricity and water fees; monitoring and control *could* be combined within one administrative system, building on China's well-established network of village electricians and well managers.

3.4.7 Finally, we note that much of the technical work has not been confined within the administrative boundaries of the Luotuocheng and Guantao pilots. Hence modelling for Luotuocheng is based on model runs for the whole Heihe mid-reach. Gaotai WAB staff pointed out that the Luotuocheng approach was being rolled out across other irrigation districts. And in Handan, the web-based groundwater simulation tool developed by ETHZ for planning irrigation water allocation accounts for impacts on local (Guantao) water levels and those in adjacent areas.

To what extent, if any, can the project generate impacts beyond China?

3.4.8 Section 3.1 above highlighted both the potential and constraints associated with wider regional-international scale-up. We note that while the approaches and tools being developed by the project are relevant to many countries experiencing water stress, the institutional capacity needed to implement them is often lacking elsewhere. Above all perhaps, the *political momentum* for action that has been building in China over the last decade or so cannot be readily re-created elsewhere.

3.4.9 That said, we think project experience, and the example being set by China more broadly in terms of its commitment to sustainable water resources management, does offer important lessons for other countries. We note that the project has already held a well-received workshop in China for 20 participants from central Asia[20] with funds from the Chinese Ministry of Science and Technology (MOST). We also understand that central Asia is a priority region for SDC. International technical cooperation has therefore begun, and could be expanded further under Phase 2 through (two-way) study tours, workshops, training events and, potentially, longer term staff secondments.

3.4.10 A more ambitious plan for addressing Objective 4 could focus on the development of a 'deeper' technical assistance programme for, say, 1-2 countries, with more significant funding from China and SDC. Central Asia would be a logical target, but SDC could also consider countries in SSA where they (and the Chinese government) have a solid base.

3.4.11 During meetings in Beijing, MWR-GIWP mentioned plans underway to develop a water resources management component to water infrastructure investment under the Belt & Road initiative. Such an initiative – if focussed on institutional strengthening - could significantly up the rate of return (economic benefits) of infrastructure projects. This would be an interesting

[20] Pakistan, Afghanistan, Kirgistan, Kazakhstan, Tadjikistan, Uzbekistan and Lebanon.

avenue to explore.

Critically assess project communication and knowledge management in terms of the quality of knowledge products, publications, outreach of project website and social media.

3.4.12 Internal communication and cooperation between project partners appears to be excellent, although Swiss partners are clearly having to navigate Chinese protocols on data storage and access with care. For example, real-time data can only be stored on Chinese servers; and data on electricity use can only be provided in hard copy. Nonetheless, the trust now established between partners is allowing challenges to be overcome.

3.4.13 We understand that Swiss partners, principally Hydrosolutions, are in almost daily contact with Chinese partners, and monthly conference calls are also held to check progress against work plans.

3.4.14 The project maintains a useful events log for both pilot sites of visits, workshops, meetings, study tours, exchanges, conference presentations and so on. Although the review team did not have time to scrutinise mission reports or workshop proceedings, discussions with Chinese partners indicated that these were highly valued, and importantly have included staff at all levels – not just senior leadership.

3.4.15 The project team has produced a rich body of written material on the technical and policy elements of the project. Unfortunately, most is buried away in annual reports for SDC and the Chinese government, and mixed up with routine reporting. Here we think there is a case for separating out the research elements from routine reporting: ideally, research should be published in working documents for external peer review. In addition, we think the project would benefit from the establishment of a reference group made up of a small group of external experts. The reference group would meet annually, and provide critical academic review of outputs.

3.4.16 In terms of external communication, the project has produced a number of technical briefing notes (fact sheets) and conference papers/posters. The briefing notes are sound but would benefit from copy-editing. A more proactive communications strategy would also see these linked to carefully timed blogs and commentaries (e.g. through the World Bank's water blogs, which include non-Bank staff). This would significantly increase readership and project-SDC profile.[21]

3.4.17 The project maintains a comprehensive and regularly updated website, hosted by ETHZ. This has links to (for example) online groundwater models, academic papers, news items and individual partner websites. While the review team have not looked at the number of site visits, downloads etc, we assume this information is being collated. We would nonetheless suggest that site 'traffic' might be significantly increased through a more proactive and joined-up communication strategy that led people to the website through blogs/commentaries.

[21] See for example this opinion piece in The Guardian's (online) business section, timed to coincide with the release of a Gates-funded ODI report on water & agriculture in China.

3.5. Sustainability

Finally, we consider the extent to which the benefits of the project are likely to continue once SDC funding is withdrawn, and any actions that may be needed to ensure sustainability.

What results have been used or have potential to be up-scaled in other areas of China?

3.5.1 This question is addressed in detail in the sections above.

What actions are still needed to establish very solid and convincing results?

3.5.2 As noted above, the review team consider that the project has *already* achieved (Heihe) or is achieving (Handan) its stated objectives, and that the quality of work is of a very high standard. We also note the impact the project has already had on policy (e.g. reforms at national and local levels) and practice (e.g. monitoring water withdrawals through electricity consumption; dialogue on control measures), with influence extending well beyond the pilot sites.

3.5.3 Looking further ahead, we think the project is well-placed to consolidate and build on these early achievements, particularly on the North China Plain. This is because: (1) the timing of the project coincides so well with the government's prioritisation of environmental issues; (2) Chinese partners have demonstrated a significant financial commitment to the work, above and beyond that which was originally foreseen in the Credit Proposal; (3) ETHZ and Hydrosolutions, in particular, have established excellent relationships with key individuals within China; this is absolutely crucial.

3.5.4 Of course more can still be done, and the sections above (and Section 4 below) identify some recommended actions. Here we pick out three key actions:

- Outreach and knowledge exchange with other programmes/initiatives to ensure wider impact and lesson-learning.
- The development of a long-term partnering and capacity building plan for work in Guantao, and the North China Plain more broadly, that identifies the institution(s) best placed to own and update databases, platforms and models, and best-placed to provide technical-management support for WABs.
- Elaboration of a more detailed proposal for supporting the project's regional-international ambitions that further encourages the Chinese government to move beyond bilateral support for infrastructure projects.

To what extent has knowledge been transferred? In future, will Chinese partners still rely on technical expertise from Swiss partners to implement findings and ensure scale-up?

3.5.5 Drawing on the discussion above, particularly Sections 3.2 – 3.4, the review team conclude that the activities carried out, and the outputs and outcomes delivered to date, have resulted in effective knowledge transfer between Swiss and Chinese partners at different levels. We also note the sharing of experience between project sites and Chinese partner organisations

facilitated through study tours, exchanges and workshops, and the length of time Swiss partners have spent in-country to build effective partnerships.

3.5.6 Most activities in Heihe have now concluded. Local WAB and ID staff now have a functioning monitoring, modelling and controlling system that they are actively using. Further technical backstopping may be required as new data are incorporated into the model, but the review team conclude that this can be provided by CAREERI, with some ongoing support from CIGEM and Lanzhou University. ID and WAB staff appeared confident in their ability to scale up and adapt systems to new areas, though all were keen to host further visits from the Swiss partners.

3.5.7 In Handan, the review team raised concerns about the long-term institutional vision for data transmission, storage, synthesis and end use. This will need to be elaborated further by partners at the outset of Phase 2, if funded. The needs of end users – WABs tasked with developing sound management plans – should be identified with users, not on their behalf. Even on the best projects, it can be tempting to 'second guess' needs in circumstances where the primary motivation of academics often lies in understanding water systems, refining models and 'optimising' systems.

3.5.8 That said, we remain confident that partners will not lose sight of their end goals. To date, there is abundant evidence of clear-minded vision. Indeed there is every reason to see further, tangible impacts at scale should funding allow.

4. Recommendations

Recommendation 1: If it ain't broke, don't fix it (but consider some mild tweaks)

- Projects of this scale and ambition benefit from a partner-donor relationship that confers trust on the project leadership, and allows partners the freedom to think, adapt, and tailor workplans to local realities. Our sense is that SDC have – rightly – allowed this to happen. This is an excellent project that is achieving its objectives.
- For this reason, our recommendations for Phase 2 are suggestive: points to think about for the upcoming dialogue on Phase 2. We are not suggesting major changes because the project is working well, and we would not like to see SDC follow the lead of some other donors in attempting to micro-manage activities and outputs.

Recommendation 2: Explore and cement links with other projects

- The project should conduct a semi-systematic review of relevant published and grey literature, supplemented with key informant interviews, to ensure lessons are learned from other studies and projects. The literature review can be published as a stand-alone document. This should have occurred at the outset, but would still yield useful insights and contacts for Phase 2.
- Linked to this, the project needs to open a dialogue with other organisations (academic and donor especially) working on the same/similar issues, and potentially convene a workshop in Beijing to share experience, align workplans, and plan future events etc. Obvious candidates include Tsinghua University, Beijing University, Renmin University, the China Institute of Water Resources and Hydropower Research, the Chinese Academy of Social Sciences/China Centre for Agricultural Policy, the Asian Development Bank and the World Bank. All of the above have worked on or funded related projects, including other groundwater management pilots.

Recommendation 3: Develop a clearer plan for partnering and capacity building

- The project needs to articulate a clear partnering and capacity building plan for Phase 2 work on the North China Plain. This should identify which organisation(s) has the capacity and authority to own, understand, adapt, update and use modelling-allocation tools to backstop WAB decision-making over the long term.
- Our understanding is that these issues are already being considered by ETHZ, Hydrosolutions and MWR-GIWP. This is reassuring. Our only observation here is that while an organisation like GIWP might have the aptitude and interest to act as 'system node', they may not have the time to ensure the groundwater model is updated over the long term. In addition, they may not have a matching interest in providing WABs with timely, user-

tailored results for informing management at local levels. CIGEM could potentially play this nodal role.

Recommendation 4: Commission more investigative field work on rural livelihoods and attitudes to reform

- The project could strengthen its work on the social sciences through an in-country partnerships with (for example) Beijing University. This would have the added advantage of bringing their experience in evaluating pilots in other areas to bear on the current project. We understand, however, that any partnership should be based on the ability of a partner to deliver work on time and on budget, and not just on their academic record.
- Objectives need to be clear. An interesting area of investigation might be around rural livelihoods and how they are changing (the growth of the non-farm rural economy; links to urban areas and alternative livelihoods), as these shifts will condition, to some extent, the political space for water reform, and the timing and sequencing of steps. A more targeted piece of research would look at farmers' attitudes to government authority, and in particular their views of water pricing, quota management and data disclosure (e.g. publishing, in simplified form, information on pumping, groundwater levels, red lines etc). The latter may be important in helping to craft, and build confidence in, the emerging management regime.

Recommendation 5: Policy options – pull the dialogue back to basics

- In its policy dialogue with government, the project should consider emphasising rights definition and management over pricing as a means of balancing demand and demand supply. The project does not have a blank canvass to work with here as government is (obviously) developing its own policies and plans. Nonetheless, the review team have been impressed by the leverage the project has had in some areas. The project team can potentially build on this by urging partners to 'keep things simple', not least for farmers.
- For farmers, somewhat suspicious of government pricing motives, and wanting simple rules that they can see others follow, quotas with real caps, adjusted in line with resource conditions, may well be preferred to tiered pricing. Such an approach would also follow international best practice. In the Murray-Darling basin in Australia, for example, rights are defined in terms of volumes and *security* of supply.

Recommendation 6: Develop a communication and engagement plan

- The project should work with a communications specialist to develop and implement a more proactive communication plan. In many projects of similar size, this would be a full-time position – and sometimes mandated by the donor. In this case a full-time position is not warranted, but part-time support is.
- The plan would identify different target audiences and needs/expectations, and identify key events (government, donor, academic, media etc) the project can target with something as simple as a blog or press release, or with a technical brief backed up by a report. For example, the team (and SDC) could plan for a public event and media coverage at Stockholm Water Week in 2019. This could involve the Minister of Water with a Swiss equivalent, and might also provide the high-level 'hook' needed to discuss wider international cooperation (see below).

- The project team has already produced a lot of written material on the technical elements of the project. Most is buried away in tome-like internal documents, however, and mixed up with routine reporting. Much better to separate out the research elements, publish as working documents – data disclosure allowing – and solicit feedback. External reports and briefs should be professionally edited.

Recommendation 7: Establish a project reference group for peer review

- The project should establish an expert Reference Group to ensure scrutiny of outputs and academic rigour. To date the project has reported to, and been guided by, a project Steering Committee. However, this may not provide the kind of detailed peer-review of outputs the project would benefit from, even in a project we judge to be performing well already.
- The Reference Group would consist of 3-4 leading academics familiar with the Chinese context, and familiar with the monitoring, modelling and controlling work being developed on the project. They could be local and/or international experts: we would recommend both. The group could meet annually with senior project staff (ETHZ, Hydrosolutions, MWR-GIWP), and would also report to the Steering Committee.

Recommendation 8: Up the global ambition?

- Working with SDC, project partners should develop a more detailed plan, in concept note form, for meeting Objective 4. This could adopt a twin-track approach. Firstly, and in the shorter term, cementing technical links with central Asian countries, building on the successful international workshop held in September 2017. This might involve co-funded workshops and study tours outside China and, potentially, staff exchanges or secondments.
- Second, and over the longer term, the project could provide a vehicle for exploring more ambitious forms of international cooperation within or beyond central Asia, with more significant funding from China and SDC for a trilateral initiative. A more ambitious conversation around ‘Track 2’ would require high-level dialogue between SDC and MWR. One approach would be to kick-start such a conversation on the back of an event planning strategy, e.g. for Stockholm Water Week (see above).

Annex A: Review itinerary

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TIME	**ACTIVITY**	**PLACE**	**PARTICPANTS**	**COMMENTS**
Monday 8 January 2018				
Morning	Roger arrives Beijing BA 39			Taxi to Great Wall Hotel
15:00-16:30	Briefing at the embassy	Swiss Embassy	TKW, YDW, RC, ZX, SDC team	Pick up tickets
16:30-18:00	Travel to Beijing West Station		TKW,YDW, RC, ZX	
19:16-21:24	Train to Handan	G567 Beijing West Station to Handan East	TKW,YDW, RC, ZX	
	Travel to Hotel	Zhao Shang Ying Bin Hotel, Handan City	TKW,YDW, RC, ZX	Handan Contact: Liu Hongliang
Tuesday 9 January 2018				
8:30-9:30	Travel to Guantao pilot region			
9:30-12:00	field visit to pilot	Guantao County		
14:00-15:00	field visit to pilot	Guantao County		
15:00-17:00	meeting with farmers	Guantao County		

17:00-18:00	Back to Handan			
20:00-22:03	Yang Dawen back to Beijing	G506 Handan East-Beijing West	YDW	
Wednesday 10 January 2018				
Morning	Meeting with Handan Water Bureau, Guantao Water Bureau, and smart meter provider	Zhao Shang Ying Bin Hotel, Handan City	Also includes CIGEM and Li Yu from Hydrosolutions	
13:28-16:14	Back to Beijing	G6742 Handan East-Beijing West	TKW, RC, ZX	
Thursday 11 January 2018				
09:25-12:00	Flight Beijing-Lanzhou	CA1239	TKW,RC,ZX	YDW's flight to be arranged by himself later
	Travel to hotel	Lanzhou Feitian Hotel 兰州飞天大酒店		Airport pick-up arranged Lanzhou Contact: Dr. Ma Chunfeng 13809312455
Afternoon	Meeting at CAREERI with			
Friday 12 January 2018				
	Presentations & discussions at CAREERI with Lanzhou Uni			
14:10-17:24	Train to Zhang Ye	D2751 Lanzhou West to Zhangye West	TKW,RC,YDW,ZX	
	Travel to hotel	Zhangye hotel		Booked by Dr.M
Saturday 13 January 2018				
Morning	Field visit to Luotuocheng pilot region		TKW,RC,YDW,ZX	program to be discussed with CIGEM/CAS

Afternoon	Back to Zhang Ye		TKW,RC,YDW,ZX	
Late Afternoon	Option 1 Meeting with Zhangye WAB		TKW,RC,YDW,ZX	
Sunday 14 January 2018				
Morning	Option 2 Meeting with Luotuocheng water authority		TKW,RC,YDW,ZX	program to be discussed with CIGEM/CAS
17:40-00:20(+1)	Flight Zhangye-Beijing (Transfer @ Xi'an)		TKW,RC,YDW,ZX	
Monday 15 January 2018				
whole day	Roger to Tsinghua Uni to meet Prof David Grey and Prof Wang Zhongjing		RC only	
Tuesday 16 January 2018				
	Meeting with MWR		TKW,RC,YDW	
	Meeting with CIGEM		TKW,RC,YDW	
	Meeting with GIWP		TKW,RC,YDW	
Wednesday 17 January 2018				
	Wrap-up, internal discussion		TKW,RC,YDW	
Thursday 18 January 2018				
09:30 - 11:30	Debriefing with SDC and MWR	MWR	TKW,RC,YDW	
Friday 19 January 2018				
am	Write-up		RC only	
pm	Roger to Beida - meeting with Prof Wang Jinxia	Beida Uni	RC only	
Saturday - Sunday, 20-21 January 2018				
	Free weekend			
Monday 22 January 2018				
	Roger departs for London			
Thursday 1 February 2018				
am	Roger to SDC Bern			
pm	Meeting with SDC staff			

Friday 2 February 2018				
am	Meeting with SDC staff			
pm	Meeting with Prof Wolfgang Kinzelbach (Project Leader, ETH-Z) and Dr Wang Haijing (Project Manager, Hydrosolutions)			
evening	Roger returns home			

Annex B: List of organisations and people met

SDC-Bern

Dr Jacqueline Schmidt	Global Programme Climate and Environment
Dr Yuka Greiler	Head, Global Programme Climate and Environment
Konrad Specker	Deputy Head, Global Programme Climate Change and Environment
Dr Manfred Kaufmann	Water & Climate Change Specialist

ETH-Zurich

Prof Wolfgang Kinzelbach	Project Leader, Rehabilitation & Management Strategy for Over-pumped Aquifers under a Changing Climate
Dr Li Yu	Post doc

Hydrosolutions Ltd - Zurich

Dr Wang Haijing	Project Manager, Rehabilitation & Management Strategy for Over-pumped Aquifers under a Changing Climate

SDC-Beijing

Mr Felix Fellmann	Head of International Cooperation Division
Dr Wang Liyan	Senior Climate Change and Environment Advisor
Ms Huo Li	National Programme Officer
Ms Hui Gao	National Programme Officer
Yuying Feng	Programme Assistant

Ministry of Water Resources - Beijing

Mr Qi Bingqiang	Division of Water Resources, Department of Water Resources Management
Ms Xu Jing	Department of International Cooperation, Science and Technology
Mr Peng Jingjun	Project Officer, Department of International Cooperation, Science and Technology
Dr Hou Jie	Director, GIWP
Mr Li Yuanyuan	Deputy Director, GIWP
Dr Chen Fei	Senior Engineer, GIWP
Dr Yu Lili	Senior Engineer, GIWP
Yang Yan	GIWP

CIGEM - Beijing

Prof. Li Wenpeng	Director/Party Secretary
Dr. Li Haitao	CIGEM
Prof. Yin Xiulan	CIGEM
Wan Liqin	CIGEM
Li Haipin	CIGEM

CAREERI – Lanzhou (Gansu Province)

Prof Xin Li	Laboratory of Remote Sensing and Geospatial Science
Prof. Zhou Jian	CAREERI
Dr. Ma Chunfeng	CAREERI

Lanzhou University (Gansu Province)

Dr Yangyun Nian	

Handan Prefecture Water Affairs Bureau – Handan (Hebei Province)

Mr Zhang Zhengliang	Chief
Mr Gu Junfang	Director of Personnel Office
Mr Yan Xiantong	Director, Water Resources Office
Mr Liu Hongliang	Staff member, Water Resources Office
Mr Chen Xinmei	Staff member, Water Resources Office

Guantao County Water Affairs Bureau – Guantao (Hebei Province)

Mr Wu Huaitao	Director

Mr Li Guangchao	Deputy Director
Mr Yao Huaixian	Director, Water Resources Office
Mr Yang Dongchao	Vice Director, Water Resources Office
Mr Fan Dipeng	Engineer
Mr Liu Liyong	Engineer

Hangaozhuan Village, Guantao County (Hebei Province)

Mr Han Guangen	Party Secretary, Chair WUA
Mr Han Hongmin	Vice Chair WUA
Mr Han Guangzhi	Member of WUA

Zhangye Prefecture Water Affairs Bureau – Zhangye (Gansu Province)

Liu Xiaojun	Zhangye Water Affairs Bureau
Liu Xiaolong	Zhangye Water Affairs Bureau

Gaotai County Water Affairs Bureau (Gansu Province)

Lei Zhenxu	Gaotai County Water Affairs Bureau
Hu Guangrong	Gaotai County Water Affairs Bureau
Xu Xuegui	Gaotai County Water Affairs Bureau

Luotuochang Irrigation District Water Affairs Office (Gansu Province)

Gu Jinhai	Luotuocheng Water Affairs Office
Xu Zhijiang	Luotuocheng Water Affairs Office

Tsinghua University - Beijing

Prof Wang Zhongjing	Dean, Department of Hydraulic and Civil Engineering
Prof David Grey	Visiting Professor (From Oxford University)

Beijing University - Beijing

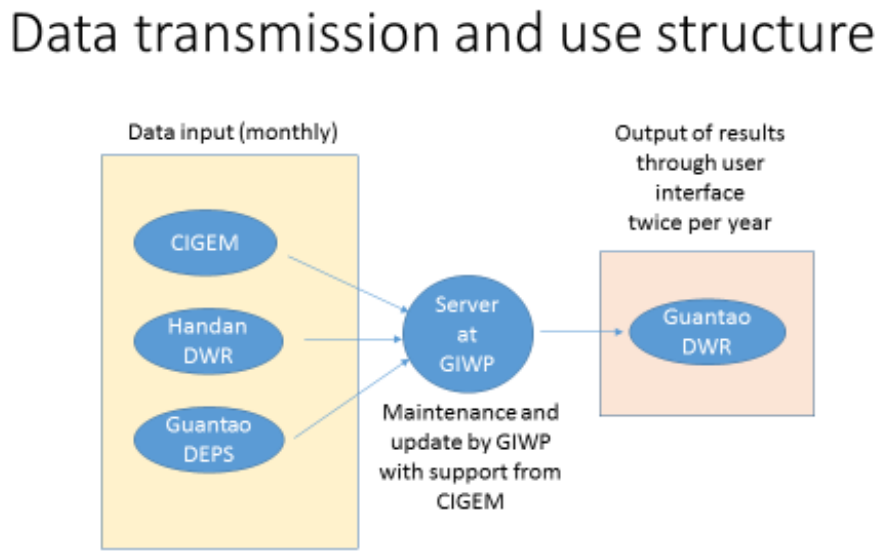
Prof Wang Jinxia	Deputy Director, Chinese Centre for Agricultural Policy (CCAP)

Annex C: Documents reviewed

Name of Report / Document	Pilot Region	Time span / Date	Document prepared for
Rehabilitation and management strategy for over-pumped aquifers under a changing climate	Heihe pilot region	Annual report (March 2015-March 2016)	Document prepared by the project team for SDC
Rehabilitation and management strategy for over-pumped aquifers under a changing climate	Handan pilot region	Annual report (March 2015-March 2016)	Document prepared for the Steering Committee (composed of Ministry of Water Resources China and Swiss Embassy)
Project Brochure	Both regions	Prepared Jan 2015	Dissemination material
Slide presentation 'for Jacqueline' showing the project sites	Both regions	Prepared Nov 2014	
Rehabilitation and management strategy for over-pumped aquifers under a changing climate	Heihe pilot region	Annual report (April 2016-March 2017)	Document prepared for SDC
Rehabilitation and management strategy for over-pumped aquifers under a changing climate	Handan pilot region	Annual report (April 2016-March 2017)	Document prepared for the Steering Committee
Project Document	Heihe Region	Nov. 2014	SDC
Project Document	Handan Region	Nov. 2014	SDC
Credit Proposal (internal management document)	Overall project / SDC internal management document	Early 2015	SDC
Database Heihe data platform: http://210.26.55.249/water/	Heihe Data		

login: admin, pwd: lzu (l as in L)			
The Handan website can be reached by: https://www.gwm-handan.cn/geoview/	Handan Data		

Annex D: Proposed data transmission and use system, Guantao



Source: Prof Wolfgang Kinzelback, personal communication. Note: draft only.

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