



Australian Government
Australian Centre for
International Agricultural Research



ACIAR POLICY BRIEF

Research findings with policy implications

GROUNDWATER FOR IRRIGATION IN LAO PDR

Promoting sustainable farmer-managed groundwater irrigation technologies for food security, livelihood enhancement and climate resilient agriculture



Mrs. Pheng waters her garden in Ekxang Village (Photo: Madeline Dahm)

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The policy brief summarizes findings, outcomes and recommendations from a research project on groundwater irrigation implemented through the collaboration of institutions from Lao, Thailand and Japan and the International Water Management Institute, and is provided at the request of Lao PDR's Ministry of Agriculture and Forestry.

SUMMARY

Groundwater can provide irrigation for rural communities where surface water is absent or unreliable. Technical, institutional and capacity limits have prevented rural communities from using groundwater for irrigation, and researchers have not demonstrated how to extract and use groundwater effectively for agriculture. A recent Australian-funded research project addresses each of these obstacles. This policy brief draws from the project's findings

and lessons to present policy options for irrigation using groundwater. It also suggests how to strengthen capacity and promote cross-sector coordination, and identifies priority areas for further research for redevelopment. This policy brief does not cover wider groundwater governance issues; another policy paper, currently in the advanced stages of preparation, will present them.

INTRODUCTION

People in both rural and urban areas rely on groundwater for their domestic needs, including household gardening and watering livestock. Almost every Laotian depends on groundwater for their drinking supplies. Groundwater also feeds springs and base-flow to rivers, streams and wetlands, supporting their health and functioning during the long dry season months. This, in turn, helps support food and nutritional security, biodiversity, tourism and other social and cultural values.

For many years, researchers have recognised that groundwater could be used for agriculture, but limited knowledge of the resource and limited institutional and human capacity have prevented

its use for irrigation. Recent research means groundwater can now be used for irrigation. An Australian-funded multi-disciplinary research project was carried out between 2012 and 2016 with support from the Australian Centre for International Agricultural Research (ACIAR). The project contributed to the CGIAR Research Program on Water, Land and Ecosystems (WLE). The project pilot tested the use of groundwater for small-scale irrigation, and assessed groundwater resources for sustainable planning, development and management. Most of the field work took place on the Vientiane Plain, and some work was also carried out in Champasak and Bolikhamxay provinces.

SECTOR SNAPSHOT

- Although the Laotian government has tried to develop irrigation over the past three decades, only around 20% of farming households have access to irrigation.
- Irrigation schemes only rely on surface water drawn from reservoirs, rivers and ponds, which are seasonal and sometimes unreliable.
- Groundwater resources are vitally important, even for a country as well-endowed with surface waters as the Lao PDR.
- Recent analysis shows that groundwater is relatively widely available and of good quality in Lao PDR, but overall volumes are limited compared to surface water. Groundwater use will need to be well managed.
- Groundwater irrigation could allow dry season cash cropping, support livestock, and be used for fisheries production. It may also allow for supplementary irrigation during the rainy season or in times of drought.



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KEY FINDINGS AND LESSONS LEARNED

- Individual farmer-managed groundwater irrigation is a successful, demand-driven approach that is simple to use and cheap to set up and maintain (refer to Case Study 2 below). It is therefore easily scalable in suitable areas (for instance, the Vientiane Plain where one-third of the area may be suitable for groundwater pumping).
- Community-based groundwater irrigation is more complex, as larger investments, collective management and specialist knowledge are needed to maintain infrastructure. It also involves and benefits poor farmers, and may be easier for the government to control than individual farmer-based systems (refer to Case Study 1 below).
- Using water efficiently and profitably is important to farmers and water resources managers. The water pumped from a borehole or well is limited, and extraction makes agricultural production more expensive. Analysis of groundwater use for rice growing shows that this is likely to be marginally economic and there is a risk that rice growing will lead to over-exploitation of the groundwater resource. Groundwater is best used for growing high-value low-water use crops, rather than dry season rice. Groundwater may be suitable for supplementary irrigation of wet season rice in drought periods.
- Groundwater for domestic purposes must always be the priority, and using groundwater for irrigation (or industry) should not compromise this.
- Groundwater irrigation needs suitable sites with adequate aquifer yields, low saline water, sufficient land and land tenure security, labour availability, farmers who know about new technologies, access to micro-credit, markets, and support from government agencies.
- Groundwater irrigation can be adopted if a community is willing to engage. Potential changes in household priorities and alternative livelihood options may influence the level of adoption^{2,3}.
- Farmers must be aware that their profitability is determined by the hydro-geological setting, the types of soils, what crops they cultivate, their agricultural practices, and market conditions. Targeted advocacy of groundwater irrigation in specific settings and for specific agricultural commodities is likely to succeed^{2,3}.
- Groundwater irrigation could be used in the Vientiane Plain, as resource assessments suggest. Resource assessments have yet to be carried out in the large, drought-prone plains of southern Laos, so the development should be limited to pilot scale demonstrations until the resource is better understood, and appropriate management systems are in place.
- Groundwater irrigation in upland areas underlain by consolidated rock may be expensive and not always cost-effective, as trials in Bolikhamxay province demonstrate.

POLICY CONSIDERATIONS FOR THE GOVERNMENT OF LAO PDR

1. Define and promote new irrigation policies that are inclusive of groundwater

Irrigation governmental policies and plans have not considered how smallholder farmers can use groundwater. If the national strategy for irrigated agriculture, and associated provincial and district level plans, included groundwater irrigation, this would help meet the targets set out in the *National Agriculture Development Strategy to 2025 and Vision to 2030* for expanding irrigated high value crops in areas with the highest production potential⁴. The strategy would be able to achieve its goals for producing food (program 1) and agricultural commodities (program 2).

Policy options

- The Ministry of Agriculture and Forestry (MAF) could include groundwater in national and local irrigation strategies and development plans. This would be subject to the caveats described above, and draw on relevant technical information^{1,2,3,5,6}.
 - MAF could promote appropriate use of groundwater in specific, well-suited locations:
 - Government and Official Development Assistance (ODA) programs and projects on food security and nutrition security, rural infrastructure development, community development and climate resilience could



An irrigated garden in Ekxang Village (Photo: Madeline Dahm)

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support and promote using agricultural groundwater.

- Government agencies, donors and private industry should make stakeholders more aware through working groups.
- MAF could support stakeholders seeking to pursue new groundwater projects; it should help them achieve success and make sure they apply best practices.

2. Strengthen institutional and human capacity of key stakeholders

Stakeholders must learn how to establish new groundwater irrigation schemes, and be trained how to effectively implement groundwater irrigation systems. Major stakeholders include the Department of Irrigation (DOI), the District Agriculture and Forestry Office (DAFO), the Provincial Agriculture and Forestry Office (PAFO), the Department of Agricultural Extension and Co-operatives (DAEC), and non-government organisations (NGOs).

Priority options

- Staff at district, provincial and central levels of MAF could be trained in groundwater development and management to facilitate successful groundwater irrigation at the field level.
- Operational manuals and related guidance should be published for agencies that implement groundwater irrigation (extension officers, local NGOs, irrigation colleges, farmer water use/producer groups).

- Forums should be held so planners and decision-makers at the national and provincial levels can exchange knowledge of groundwater management.
- MAF could co-ordinate study visits and knowledge exchanges to demonstration sites in the Lao PDR and/or neighbouring countries with innovative projects.

3. Promote cross-sectoral coordination

The Ministry of Agriculture and Forestry (MAF) can establish more effective linkages with other water, agriculture, energy and public health ministries, and define clear roles and responsibilities for each. Groundwater irrigation could use much of the replenishable groundwater resource, so MAF is well placed to co-ordinate implementation through its specialised departments, including the Department of Irrigation (DOI). It would work with the newly formed Groundwater Management Division (GMD) in the Ministry of Natural Resources and Environment (MONRE), Nam Saat in the Ministry of Health, the Department of Housing and Urban Planning in the Ministry of Public Works and Transportation.

Priority options

- MAF, in partnership with MONRE, could establish a cross-sector working group (CSWG) represented by the agencies listed above to co-ordinate how ministries and departments manage groundwater across policy formulation, project planning, resource assessments, monitoring, land use planning, regulation/enforcement and research.

- This CSWG could develop or strengthen development agencies, private industry and government's standards in groundwater project implementation. It should also make sure they adopt these standards to more effectively deliver services, generate knowledge and build capacity.
- The CSWG could develop regulations and enforcement controlling large-scale commercial development to avoid polluting or over-pumping the groundwater storage.
- The CSWG could introduce reasonable pricing on groundwater withdrawals for large-scale investments, and subsidies on energy/fuel use for pumping groundwater for small-scale (poor) farmers.
- The CSWG could support mandated agencies such as GMD to set up regional/national monitoring networks building on infrastructure from past or present projects.

4. Continue to invest in research for redevelopment

Investing in research strengthens the knowledge base, and promotes sustainable development. It also

helps build the capacity of those in or newly entering the sector.

Priority areas

- Make groundwater irrigation more gender-sensitive, inclusive and equitable to benefit the community.
- Maintain sustainable groundwater resources through participatory monitoring and management, or through linking groundwater management to the management of community irrigation.
- Expand operational experience in groundwater irrigation in new settings. Geographic focus could be given to hard-rock areas, which extend across the Lao PDR, and to the lowlands of southern Laos, potentially building on related ACIAR-supported work.
- Use solar-powered groundwater pumping to make agriculture more profitable and to help communities adapt to climate change and mitigate its effects.
- Manage conjunctive use of surface and groundwater in existing large- or medium- scale schemes to better understand the complimentary roles between canal irrigation and groundwater.

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CONCLUSION

Irrigation can reduce poverty and enhance livelihoods for rural communities. These benefits can also apply where surface water cannot be used and groundwater must be used instead. Recent ACIAR-supported research has significantly boosted the knowledge and expertise to develop groundwater resources for irrigated agriculture and manage these resources sustainably. Using groundwater for irrigation is feasible and profitable for farmers. Policy options should take this forward:

1. Define and promote new irrigation policies that include groundwater;
2. Strengthen key stakeholders' institutional and human capacity ;
3. Promote cross-sectoral co-ordination through a cross-sector working group on groundwater; and
4. Continue to invest in research to fill knowledge gaps.



IWMI Research Technician Touleelor Sotoukee and Intern Lengya Valee collect a data logger from a well in Vieng Khan Village (Photo: Madeline Dahm)

CASE STUDIES ON TWO TYPES OF FARMER-MANAGED IRRIGATION

Case Study 1. Community-based groundwater irrigation²

Researchers, working with farmers and local authorities, established the first community-managed groundwater irrigation trial in the Lao PDR at Ekxang village in Phonhong district, so farmers could use groundwater to grow cash crops during the dry season. The system comprises two 30-metre deep tube wells tapping an alluvial aquifer and fitted with electric-powered submersible pumps that irrigates adjoining paddy lands.

During the evaluation period in the dry season of 2015/16, four farmers participated in the trial. They irrigated ten crop types over a total area of 1.5 hectares. The research project subsidised pumping and some maintenance costs for the first year, to initiate adoption. Dry season cash-crops generated modest profits (even without the project subsidy), while only the subsidy made rice profitable. Farmers cultivating many cash crops would have generated net profits over the dry season ranging from LAK 1 to 7 million (AUD 170–1,200) without the subsidy. One farmer cultivating rice on a 0.8 hectare plot would have lost LAK 2 million (AUD 340) without the subsidy.

The scheme can irrigate around 6 to 9 hectares, depending on what cropping patterns and irrigation methods the farmers choose. The groundwater irrigation system is economically viable if farmers take up the system. Assuming a 6-hectare irrigated area and full adoption, investment would cost around LAK 18 million / hectares (AUD 3,100 /ha), and the Internal Rate of Return (IRR) would be as high as 45%.

The community helped to develop the irrigation system. The Ekxang groundwater user group was formed, comprising seven farmers, including one female (Deputy Head). Those from the group who have participated so far have land in the irrigated area, and earn most of their income through on-farm activities. The group have overcome their initial doubts, and have begun to value the system and demonstrate they can function effectively. Observations made in the current dry season (2016/17) indicate the user group is still functioning, and a similar level of farmers are taking it up on an unsubsidised basis. The Department of Irrigation (DOI) is monitoring the trial, and bringing students from the Tha Ngon Irrigation College to visit the site for practical training.

We can increase our income and production using groundwater to grow cash crops in the latter part of the dry season when all the surface water dries out. Groundwater also lets us start our wet season farming on time if the rains start late.

Mr Mon, Head of Ekxang village

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Case Study 2. Individual farmer-based irrigation

Better-off farmers in some parts of the Vientiane Plain have taken to excavating open dug wells (large pits) in their fields to depths of around 4 to 10 metres. Using very simple pump-sets (two-wheel diesel tractor or "tok tok"), they deliver water through a small pipe to the field where furrows distribute it for dry season production of crops, such as watermelon or yard long bean.

Evaluation of two farms showed it was a simple and profitable method to irrigate cash crops during the dry season. Each farmer grew about one hectare of watermelon. The returns easily justify the LAK 4 million (AUD 670) investment to construct a dug well. For the first half of the 2014/15 dry season studied, profits ranged from LAK 19 to 31 million (AUD 3,200–5,200) per farmer. Estimated profits were between LAK 15 and 45 million (AUD 2,500–7,500) for the entire dry season cultivation over the period from 2011–2015. High market price volatility, and different input costs between winter and summer crops all affected farmer revenues.



ENDNOTES:

- 1 Coulon, C et al. (forthcoming) Recent progress towards more effective groundwater governance in Lao PDR. Manuscript intended for publication in the Groundwater Solutions Initiative for Policy and Practice (GRIPP) Case Study Series.
- 2 Clément C., Vinckevleugel J., Naolee K., Sotoukee T., Pavelic P., Vongsathiane K. and Raj Shivakoti, B. (forthcoming) Community-managed groundwater irrigation on the Vientiane Plain of Lao PDR: Trial implementation and results from the first season of operation. Manuscript submitted for publication as an IWMI Working Paper.
- 3 Suhardiman et al., (forthcoming) Putting farmers' strategies central in understanding agricultural groundwater use in the Vientiane Plain, Laos. Manuscript submitted to the Journal of Hydrology.
- 4 Ministry of Agriculture and Forestry (2015) Agriculture Development Strategy to the year 2025 and Vision to 2030. MAF, May 2015. Published in Lao and English.
- 5 Viossanges, M. Sotoukee, T., Pavelic, P. and Rebelo, L-M. (forthcoming) Mapping groundwater resources potential of Lao PDR. Manuscript to be submitted to Journal of Hydrology: Regional Studies.
- 6 K. Brindha, Pavelic, P. and Sotoukee, T. (forthcoming) Environmental assessment of water and soil in the Vientiane Plain, Lao PDR. Manuscript submitted to Environment Asia.



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