Food and Agriculture Organization of the United Nations

KnoWat: Knowing water better

Towards a more equitable and sustainable access to natural resources to achieve food security

Project results in Sri Lanka

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Project results in Sri Lanka

Further information

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Around the world, countries struggle to adapt agricultural and food systems to conditions of water scarcity, climate change and increased competition between resource users. These struggles are only expected to increase. Smallholder farmers are particularly vulnerable to changes in water access and availability because it can mean a sudden loss of income and food.

A greater focus on water accounting and water governance is crucial for addressing water scarcity in a changing climate to ensure food and water security for all. Our capacity to manage and use water resources efficiently and equitably requires us to understand the quantity and quality of water that is available and the rules that govern access to water.

In response to these challenges, a project led by the **Food and Agriculture Organization of the United Nations** (FAO) – 'Knowing water better: towards fairer and more sustainable access to natural resources" (KnoWat) – has built stronger water governance processes in Rwanda, Senegal and Sri Lanka. The project has strengthened national capacities in water accounting water productivity in agriculture, using the latest remote sensing technologies and training hundreds of water experts. KnoWat has developed and tested a methodology for assessing water tenure to shed light on the rules and regulations governing access and allocation of water resources. This information is crucial for improving water use, ensuring the equitable allocation of water resources and increasing the resilience of societies to climate change.

The KnoWat project is implemented by FAO in close cooperation with partners at global, country and local levels. KnoWat is funded by the **Federal Ministry of Food and Agriculture of Germany** (BMEL).

In Sri Lanka, the project is implemented in partnership with the **Department of Irrigation**.

This short publication summarizes the key accomplishments of the KnoWat project in Sri Lanka. It is hoped that the project will improve our understanding of water and will strengthen the institutions and people responsible for managing a resource that is critical to the livelihoods and food security of all people and a foundation of natural ecosystems.

Background and challenges

Sri Lanka is an island country in the Indian Ocean with a land area of 65 610 km2 and a population of 21.6 million. It has a network of approximately 103 principal rivers and tributaries, most of which originate in the central and southern parts of the country.

There are three climatic zones in Sri Lanka: the dry zone (annual rainfall less than 1 750 mm), the intermediate zone (annual rainfall 1 750–2 500 mm) and the wet zone (annual rainfall 2 500–4 500 mm). The only source of water is direct rainfall. The biggest user of water is agriculture.

Agriculture contributed around eight percent to national GDP in 2020. Rice is the most important crop, producing 4.1 million tonnes in 2019–2020, enough to feed the entire population of the country. Paddy is grown all over the country, mainly during two monsoon seasons, the Maha season from September to March and the Yala season from April to September. Rice contributes to 1.8 percent of country's GDP and 1.8 million families are engaged in its production. About 983 550 hectares are under paddy, 43 percent of all agriculture lands.

According to the Climate Risk Index 2021, Sri Lanka is the thirtieth most climate-vulnerable country in the world. The country is highly susceptible to extreme weather events such as prolonged droughts.

Due to population growth, economic growth and industry-led deterioration of water quality, the competition for water and water scarcity have increased in recent years.

Agriculture accounted around **8%** of Sri Lanka's GDP in 2020 and is the **biggest user** of the available water

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Project area: Malwathu Oya Catchment

Source: United Nations Geospatial. 2020. Map geodata [shapefiles]. New York, USA, United Nations, modified by the author. Lakes and rivers data from Natural Earth Data and catchment data from Hydrosheds.

The Malwathu Oya basin is the second largest river basin in Sri Lanka (3 284 km2) and one of the major agricultural areas in the country.

The KnoWat project area, the Malwathu Oya's southern catchment, extends over 77 950 hectares. The population in the area has been estimated at 204 775. Agriculture, and especially rice farming, is the predominant household livelihood.

Results

KnoWat established a geospatial database based on FAO's Water Productivity through Open-access of Remotely sensed derived data (WaPOR) tool. The database covers all Sri Lanka and, at a higher resolution, the Malwathu river basin. Thus, Sri Lanka is the first Asian country to have a WaPOR database. A comprehensive water resources assessment of Sri Lanka and Malwathu river basin have been carried out to acquire key data and information on water accounting, governance and water productivity.

The project built the capacities of technical staff of key government institutions at national, basin and local level on the use and management of data for better water management, and identified different development pathways for agricultural development in the basin.

The KnoWat project worked to raise awareness between national stakeholders from government, civil society, private sector and media on the issues of water scarcity, water access and agricultural water productivity, and the linkages between water tenure and climate change.

WATER PRODUCTIVITY

Building capacities to apply WaPOR data

In cooperation with the International Water Management Institute (IWMI), the KnoWat project trained 30 experts from Sri Lanka to use and interpret WaPOR datasets.

Developed by FAO, WaPOR monitors water productivity in near-real time through remote sensing, identifies water productivity gaps and proposes solutions to address these gaps. Key national partner institutions, including the Irrigation Department of Sri Lanka, the Department of Agrarian Development, the Department of Land Use Policy Planning, the Department of Census and Statistics and the University of Peradeniya, now have the tools to use WaPOR to better manage water resources.

Project partners in Sri Lanka are currently studying the application of WaPOR for the System for Environmental Economic Accounting for Water (SEEA-W) as well as for monitoring Sustainable Development Goal Indicator 6.4.2 on water stress.

Assessing crop water productivity in Malwathu Oya using remote sensing

Different data on water resources are needed to assess and improve water management. In Sri Lanka, the lack of reliable data on water resources made for example agricultural predictions, plans and decisions challenging. Data was collected manually which requires a lot of time and is prone to errors. The KnoWat project established a modern geospatial database based on the FAO's WaPOR tool.

Crop water productivity assessment: main findings

To demonstrate the usefulness of WaPOR in areas of scare water resources, the KnoWat project carried out a crop water productivity assessment in the Malwathu Oya southern catchment in 2022.

One of Sri Lanka's most important agricultural zones, the catchment area is prone to extreme weather events due to climate change. These include severe water scarcity and floods, which challenge farmers' work and lives. Inefficient water use in agriculture, particularly in paddy, and poor irrigation infrastructure exacerbate the situation.

The area covered by WaPOR extends over 779 km2 and includes the fields of more than 200 000 farmers. The water productivity assessment only considered only paddy rice cultivation, since this consumes the most water through irrigation.

The water productivity assessment analysed rice yields in the project area during the Maha monsoon season (1 October–30 March) between 2015 and 2022. Yields of paddy rice ranged from 3.8 to 4.8 tonnes per hectare. The highest yield was achieved in 2017–2018. Yields are lower here than in other districts in Sri Lanka, but are around the global average of irrigated rice yield (4.5 tonnes per hectare).

Voices from the field

"The WaPOR database is very helpful in the tasks performed by the Irrigation Department for water resources planning. After assessing the water availability and the water use efficiency for better water management, we can plan better our actions, especially in the dry zone of Sri Lanka, where almost all the major, medium irrigation schemes are situated."

Engineer Medhani A. Jayakody, Chief Engineer of the Water Resources Planning Branch, Irrigation Department of Sri Lanka

Further information

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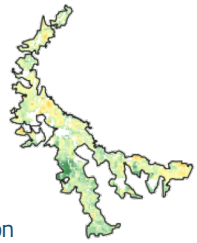
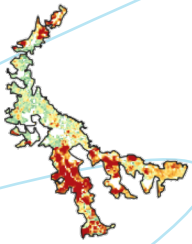
Nachaduwa irrigation scheme: Rice yield, Maha season, 2015-2022

Season 2015-2016
mean. 4.86 t/ha/season



Season 2017-2018
mean. 4.63 t/ha/season



Season 2021-2022
mean. 3.5 t/ha/season

- 2 ton/ha/season
- 3 ton/ha/season
- 4 ton/ha/season
- 5 ton/ha/season
- >6 ton/ha/season

FAO. 2022. Water Productivity through Open-access of Remotely sensed derived data (WaPOR). In: FAO. Cited 16 December 2022. https://wapor.apps.fao.org/home/WAPOR_2/

The project assessed irrigation performance indicators to discover the underlying causes of low water productivity of paddy in certain zones of the pilot area. The assessment revealed that irrigation is neither adequate nor uniform across the basin. Both land and crop water productivity of paddy rice cultivated during the Maha season in the Malwathu Oya southern catchment had a high spatial and temporal variability. These findings can be used by irrigation experts to identify hot spots and bright spots increase the water productivity in the Malwathu Oya basin.

The assessment also analysed the yield assessment in the Nachaduwa irrigation area (left). In this area, irrigated crop yield reaches more than 6 tonnes per hectare, while farmers in the rest of the catchment produce less, between 2 and 5 tonnes per hectare. It would be interesting to study the reasons for the higher yields in Nachaduwa. Do farmers there apply good practices that farmers in other areas could benefit from?

The assessment identified a number of challenges, including uncertainties in the land cover maps provided by WaPOR, which may have been affected by the high cloud cover of satellite images during the main growing period. In some areas, the fields were often too small (less than 1 hectare) to be detected by remote sensing at 30 metres resolution. Trustworthy local data on crop cover and crop calendar are needed to ensure reliable irrigation performance assessments. WaPOR works best on large fields with a uniform crop cover and calendar; such was the case in the Nachaduwa irrigation scheme.

The application of WaPOR for water productivity and irrigation performance assessment should continue to improve, thanks to ongoing research by university students supported by the KnoWat project in collaboration with the International Water Management Institute (IWMI).

The project also supported the organization of a major capacity building programme from 21 to 24 September 2021 in Saly, Senegal, as part of the joint project "Improving Land and Water Productivity in the Sudano-Sahelian Belt," funded by FAO. The session assisted about twenty national experts to strengthen their capacities in the practical use of the WaPOR tool.

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Water accounting and auditing assessment

Water accounting and auditing are an essential aspect of managing water resources. **Water accounting** is the systematic examination of status and trends in the availability, demand, accessibility and usage of water. **Water auditing** puts trends in water supply, demand, accessibility, and usage into a broader framework of governance, institutions, public and private expenditure, law and the political economy of water. When combined, water accounting and auditing facilitate policy development and decision-making.

In addition to the water accounting and auditing assessments, the KnoWat project carried out a water productivity study in an area found to have low water productivity.

The water accounting study focused on ten subwatersheds of the Malwathu Oya catchment over four seasons. In each case, water balances were calculated with inputs from the WaPOR database, based on the Soil and Water Assessment Tool (SWOT), which is commonly used for hydrological studies by the Irrigation Department of Sri Lanka. These water balances were compared with observed hydrological data. The study showed that the flows based on the SWOT and WaPOR data were between 4 and 13 percent higher than the observed flows. It concluded that the model replicates the situation on the ground quite well and can be used in future water balance studies.

The water auditing study focused on three case studies in areas where there is an issue with water management:

1. **Water sharing between agricultural and domestic uses and the issues of unavailability of water from a tank in Thuruwila.** The auditing study discovered that enhancing collaboration between area officials and the farmers could help solve issues related to water sharing by drawing on the practical knowledge of the farmers.
2. **The Nuwara Wewa feeder canal and the issue of illegal use of water.** In this case, irrigation officials believe that the illegally-irrigated lands should be legalized because siphoning is difficult to control.
3. **Water management in areas of low water productivity in the Nachchaduwa irrigation scheme.** The water productivity analysis revealed inadequate maintenance and cleaning of the canal, which caused flooding and, as a result, low water productivity. In addition to improving the canal system, the establishment of better facilities for accessing and using the infrastructure should be considered.

The results of the water accounting and auditing studies were validated with stakeholders at local and national levels. The information can underpin better decisions on water management in the future.

Assessing water tenure for food security, equity and climate adaptation

Water tenure determines how people obtain rights to water resources, including the rights to access, impound, use and manage water, gain access to information and participate in decisions on water resources management.

To ensure equitable distribution to all legitimate rights holders and to protect natural ecosystems, it is important that existing water tenure arrangements are coherent and all legitimate tenure rights are recognized by national legislation.

Water tenure arrangements can be very complex and vary considerably, including within the same country, influenced by local and social practices, traditions and status, geography, environment and livelihood practices. Different water tenure arrangements may coexist and overlap in the same region, and water tenure holders may be part of more than one water tenure arrangement.

> Water tenure can be defined as the **relationship**, **whether legally or customarily defined, between people, as individuals or groups, with respect to water resources**.
>
> See: Hodgson, S. 2016. Exploring the Concept of Water Tenure. FAO Land and Water Discussion Paper 10. **Food and Agriculture Organization of the United Nations**.

The assessment methodology

The KnoWat project developed a water tenure assessment methodology to identify and analyse the diversity of water tenure arrangements that may exist within a catchment or community. The methodology includes desk research and field data collection as well as capacity building and consultations with decision-makers, national stakeholders and local people that depend on water for their livelihoods. The assessment is carried out by a multidisciplinary team, which includes legal and sociological experts.

It allows the identification and the analysis of water tenure arrangements deriving from different sources, including formal, customary, traditional and indigenous systems. Formal law, often described in terms of 'water rights,' includes permits, licenses, small-scale so-called 'free uses,' concessions, contracts, membership in water users' associations and legal powers conferred on public bodies. Local communities and indigenous peoples that exercise self-governance over natural resources may apply their own rules to the allocation, management, use and protection of water resources. Communities often share resources based on social, cultural or religious norms, some of which may be recognized in formal law.

The assessment methodology follows a six-step approach to categorize water tenure arrangements and determine their perceived security. It also permits the analysis of governance institutions and the identification of potential conflicts and their resolution through the application and revision of legal frameworks and local practices. The methodology allows comparisons between countries and between different regions in the same country while highlighting the specificities of each study area. The analysis provided by the assessment assists policymakers to define and safeguard the rights of all tenure holders and to determine how to safeguard water resources for users, while ensuring food security, livelihoods and the integrity of natural ecosystems.

[1] Hodgson, S. 2016. Exploring the Concept of Water Tenure. FAO Land and Water Discussion Paper 10.

Water tenure assessment in Sri Lanka

The KnoWat assessment identified and compared various water tenure arrangements in the Malwathu Oya river basin project area, as well as at the national level, and highlighted the threats, issues and conflicts involved. It provided recommendations for decision-makers on how to achieve more responsible and equitable governance of water tenure.

Currently, 52 legislations govern Sri Lanka's overall water sector. Forty state agencies housed in various line ministries are involved in administering water resources and addressing challenges related to water resources.

Key recommendations for the responsible governance of water resources tenure

- **Improve the management of irrigation water**, particularly monitoring the provision of irrigation water to calculate the exact and adequate amount of water needed for paddy. This is important since irrigation is the main water user.
- **Bring all water sector institutions under one umbrella** to simplify collective and inclusive planning, reduce costs and speed up decision-making in the water sector.
- **Establish an overarching policy to govern the water sector** and an appropriate governance structure for basin management .
- **Implement existing rules and regulations to control illegal and unregulated water use** and reduce water-related conflicts between water users and tenure regimes.

© FAO/Benjamin Kiersch

KnoWat field mission in Sri Lanka, October 2019.

- **Streamline water sector laws and have a separate water law for the country.** Most water laws are out of date and responsibilities are spread out among large number of agencies. There is also overlap, with some water sector government agencies implementing other agency's acts rather than their own.
- **Review the provincial administration layer created by the 13th Amendment of the Constitution**, taking into account the issues between central and provincial government agencies and come up with an acceptable solution to overcome the issues to improve collaboration and coordination, in particular regarding water governance.
- **Improve coordination among existing water sector agencies** by implementing common systems and procedures and encouraging participatory water sector planning.
- **The role of project management committees (PMCs) in water tenure governance and water management should be further strengthened** with a view to providing equitable and sustainable water services for all. Membership of the PMCs should be expanded to include all water sector stakeholders.
- **At the national level, strengthen the water management panel for science-based decision-making** and participatory water management mechanisms.
- **Establish free sharing of data and information** among water users and institutions to enable better decision-making.
- **Introduce modern water tenure arrangements** where possible to minimize water tenure insecurity.

Stories from the field

Reaping the fruits of data in the paddy in Sri Lanka

In Sri Lanka, an island in the Indian Ocean, a shimmery green river snakes through paddy fields and forests, unhurriedly towards the ocean in the northern part of the country. The 164-kilometer long Malwathu Oya river is the second longest river in the country and a lifeline for people living nearby.

W.A. Ramani Perera drying harvested paddy. © FAO/Kolitha Bandara

The river's southern catchment supports around 200 000 local people, who are mostly engaged in farming, providing them with water for drinking, sanitation, hygiene, and to irrigate their paddies.

The cultivation of rice has been practiced here for thousands of years: ancient civilizations flourished in the dry area of the country partly due to their irrigation systems. Sri Lanka was once known as the 'granary of the east.'

To this day, the cultivation of rice is essential to Sri Lanka's people, their culture and the economy: 43 percent of all agriculture lands are under paddy, and rice contributes to 1.8 percent of country's GDP.

But in recent times, some paddies have been unable to produce, due to the impacts of climate change and related extreme weather events, such as prolonged droughts and fierce floods.

"Drought destroyed the harvest of one cultivation season in 2012 and then we had floods submerging our paddy fields. Our crops have been destroyed twice by floods since 2016," explained W.A. Ramani Perera, President of the Ranketha Farmer's Association and Treasurer of the Farmer's Association.

Since most of the southern catchment's inhabitants are engaged in farming, a lost harvest means the loss of an important part of their income and even food – normally the farmers have two harvests per year. This begged the question: what could be done to plan and manage better water resources in the southern catchment to control floods and to ensure enough water for irrigation, even during dry periods?

Cutting-edge data and intense training

From 2019 to 2022, FAO's KnoWat project carried out a number of activities in the Malwathu Oya southern catchment and at the national level to improve water resources planning and management.

The first step was to establish a near-real-time database on agricultural water consumption and water productivity, building on FAO's Water Productivity Open-access portal (WaPOR). The database was created by analysing satellite images and comparing them to on-the-ground observations.

Prior to the project, data and information was inadequate to allow proper planning and management of water resources. The water balance was done by hand and based on field observations, requiring a great deal of time and energy.

"[Manually g]athering ...[all of the] hydro-metrological and climatic data needed [for] assessing and improving water resources was difficult...," confirmed Medhani Jayakody, Chief Engineer of the Water Resources Planning Branch at the Irrigation Department of Sri Lanka.

The WaPOR data from the catchment, as well as national data at different resolutions, are now freely available to water resource management officers for conducting water balance studies.

"Allowing [us] to use near real-time data with acceptable resolutions, WaPOR is going to bridge the gaps in data, cut down the cost and filling the gaps in new technology in water resources assessment" said T. K. A. Kodippili, an engineer at the Irrigation Department of Sri Lanka.

The KnoWat project also built the capacity of local people to use the WaPOR database. Thirty men and women from different water sector agencies in Sri Lanka received training on water accounting and auditing. In addition, the project engaged with the next generation of water decision-makers, by assisting universities to include WaPOR on the curricula of agronomy students and to incorporate WaPOR into research projects.

Today, engineers, water management experts and academics can get a wealth of information from WaPOR that will help them to find solutions for managing water better in catchments and irrigation schemes.

"Using water productivity assessments at scheme level will be important in seasonal planning for better water management, and the decisions can be made ...[at the start] of the season on the best crop type, water quantity to be used," xplained Medhani A. Jayakody.

Rice is the main irrigated crop in Sri Lanka. From 2019 to 2020, 4.1 million tonnes of rice were produced in the country, enough to feed 21.6 million people. © FAO/Sri Lanka office

Water resources managers reap the benefits of the data, but farmers are the ultimate beneficiaries. "A farmer who lives in a remote village does not know anything about WaPOR, but can benefit from WaPOR through a designed plan for proper water management after assessing the water productivity on ...[their] plot. The benefit they will receive is a good harvest due to having improved water management and seasonal planning. The good plan can ensure them a good income from their cultivations," explained T.K.A. Kodippili.

Moving forward with new knowledge

Water managers have long maintained that good water resources management is critical to the equitable access and use of water.

In times of water-related challenges, such as brought on by climate change, water accounting and auditing are essential aspects of planning water resources management. Water accounting involves the systematic examination of the status and trends in the availability, demand, accessibility and use of water. Water auditing, on the other hand, examines trends in water supply, demand, accessibility and use in the broader framework of governance, institutions, public and private expenditure, law and political economy. When combined, results from water accounting and auditing facilitate policy development and decision-making.

The KnoWat project carried out a water accounting and auditing assessment in Sri Lanka's Malwathu Oy southern catchment, as well as a water productivity study in an area identified as having low water productivity.

The water accounting study focused on ten subwatersheds in the Malwathu Oya southern catchment over four seasons. In each case, water balances were calculated using the Soil and Water Assessment Tool (SWOT), which is commonly used by the Irrigation Department of Sri Lanka, with inputs from the WaPOR database. These balances were compared with observed hydrological data. The flows calculated with SWOT and WaPOR were generally higher than the observed flows, by about 4 to 13 percent. This indicates that the model replicates the situation on the ground quite well and can be used in future water balance studies.

The water auditing case studies focused on three cases of unsustainable water management: i) water sharing between agriculture and domestic water uses and the unavailability of water from a tank in Thuruwila; ii) the Nuwara Wewa feeder canal and the illegal use of water; and iii) areas of low water productivity in the Nachchaduwa irrigation scheme.

In Thuruwila, it was discovered that by improving collaboration between farmers and area officials, the farmers were encouraged to share their practical knowledge in the high-level discussions, helping to resolve the water-sharing issue. In the Nachchaduwa-Nuwara Wewa feeder canal, officials concluded that the use of water for irrigation should be legalized because siphoning is difficult to control. In the Nachchaduwa irrigation scheme, the study revealed that inadequate maintenance and cleaning have led to flooding and, as a result, low water productivity. The study called for improvements to the canal system and better facilities for accessing and using the canal infrastructure.

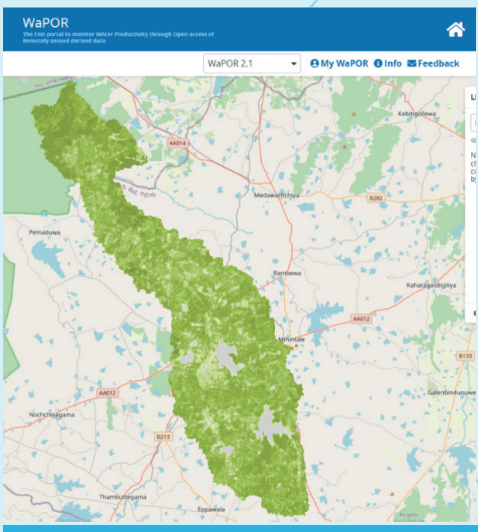
"Each area has its own challenges related to water management. Thanks to the water accounting and auditing assessments and the validation workshops, the stakeholders and decision-makers have now more information [on which] to base their decisions for development," explained Thushara Ranasinghe, KnoWat project's National Coordinator in Sri Lanka.

A strong focus on water management is critically important for Sri Lanka, as the population continues to increase and climate change increasingly impacts the food security of rural people.

"…[T]he challenge of the decade is how to feed the planet's growing population sustainably, amidst climate and water crisis? With more than 733 million people currently living in areas of high or critical water stress and a projected 30 percent increase in global water demand by 2050, water allocation has never been more important," said the project's global coordinator, Benjamin Kiersch.

Over four years, from 2019 to 2022, the KnoWat project worked to improve water resources management in Rwanda, Senegal and Sri Lanka. The results of the project in the three countries will complement FAO's work on water tenure, as it initiates a "Global Dialogue on Water Tenure."

Water accounting and auditing training for postgraduate students on 28–31 March 2022 at the University of Peradeniya. © FAO/Sri Lanka office



Sri Lanka is the first Asian country to have the WaPOR database. The map shows crop water productivity in the project area in December 2021: the greener the area, the higher the crop water productivity; the grey areas have low water productivity.
Source: Water Productivity through Open-access of Remotely sensed derived data (WaPOR) .

KnoWat: Knowing water better

Towards fairer and more sustainable access to natural resources for greater food security

Rwanda, Senegal and Sri Lanka (2019–2022)

Further information

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All around the world, countries are struggling to adapt their agricultural and food systems to conditions of climate change and to extreme weather events such as long periods of drought or heavy rains. Water scarcity is expected to increase as is competition for water resources among users. Smallholder farmers are particularly vulnerable to changes in water access and availability: a sudden lack of water due to drought can mean lost income and food, threatening their lives and those of their families. For these reasons, major efforts are needed to address the links between water scarcity, food security and livelihoods in our changing climate.

The KnoWat project takes an integrated approach to water resources management that includes water accounting, water productivity, water governance and water tenure assessments.Water accounting is the systematic study of current status and future trends in water supply and demand in a given spatial domain. Water productivity in agriculture signifies the ratio between yield and the water consumed by a crop. To support water accounting and productivity assessments, the KnoWat project built the capacities of key partners to apply FAO's Water Productivity Open-access Portal (WaPOR). This tool assesses water consumption in agriculture and the water productivity of agricultural production using remote sensing.

Water governance assessment looks at the broad framework of institutions, finance and the political economy. To better understand water governance processes, the project developed and tested a new methodology to assess water tenure, the formal and informal arrangements used to access water. The assessment of water tenure aims to understand the different relationships between people and water resources.

Enriching our knowledge around water through accounting, productivity, governance and tenure assessments helps policy and decision-makers to plan and implement better policies, with the ultimate goal of ensuring equitable water allocation for better livelihoods, food security and healthy ecosystems, even under conditions of growing water scarcity.

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Federal Ministry of Food and Agriculture

This project is supported by the **Federal Government of Germany** and implemented by the **Food and Agriculture Organization of the United Nations** (FAO).

In Sri Lanka, the project is implemented in collaboration with the **Department of Irrigation**. The country activities were implemented in collaboration with the **International Water Management Institute** (IWMI), the **Post Graduate Institute of Agriculture** of the **University of Peradeniya** and **E-leaf**.

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