



WATER STEWARDSHIP IN SUSTAINABLE AGRICULTURE

FARM AND CATCHMENT LEVEL ASSESSMENTS



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Sustainable agriculture is the efficient production of safe, high quality agricultural products, in a way that protects and improves the natural environment, the social and economic conditions of farmers, their employees and local communities, and safeguards the health and welfare of all farmed species.

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1. Introduction

Water is one of the most critical aspects of sustainable agriculture, both for the industry itself, and for its impacts on the natural environment and other water users. Agriculture is responsible for 70% of the world's freshwater withdrawals, and up to 90% in some developing countries. The agricultural sector, therefore, provides a vital opportunity to improve global water stewardship over the coming decades of increasing population and water demand. This document is best read in conjunction with the earlier one: *Water stewardship in sustainable agriculture – Beyond the farm towards a catchment approach* (SAI Platform 2013). See References for a download link.

Water stewardship has two key objectives in the agricultural sector:

1. To protect a farming operation from water-related risks
2. To demonstrate social responsibility by minimising negative impacts of a farming operation on other water users and the natural environment.

This document provides practical guidance on the steps required for farm level water stewardship in a catchment context.

There are already many tools and guidance documents on corporate water stewardship, some specifically including agriculture. Most 'make the case' for water stewardship and are a strong driver for action. They give an overview of *types* of risk likely to be important, but cannot accurately define actual and site-specific risk. The main value of global tools is in providing a high level and first pass assessment. Site-specific knowledge and choosing of site-specific actions can only be achieved through a local level assessment with specialist support. More discussion on global tools is given in Appendix 2.

The target audience of this document is business leaders and managers who recognise the need for farm level water stewardship (whether on their own or suppliers' farms) but who are not water experts. The aim is to empower key decision makers:

- To understand the scope and steps of farm level water stewardship
- To understand where specialist experts are required
- To be in a stronger position to make the right practical and investment choices
- To be better equipped to support CSR reporting on water related issues
- To be better informed for communication on water stewardship

The current document addresses the three practical key elements on the road to farm level water stewardship. These are:

1. Knowledge: a prerequisite to reliable risk assessment
2. Risk: from two aspects (i) risks to the farm, and (ii) risks from the farm to others and the natural environment
3. Actions: to address and mitigate risks

Further supporting information is provided in Appendices 1 to 3. In addition:

- Appendix 4 identifies links to the SAI Farmer Sustainability Assessment
- Appendix 5 proposes a model for water risk indicators that can guide practical actions.

2. Applying a catchment approach

A critical requirement for farm level water stewardship is to apply a catchment (or river basin) approach. Water management on a farm is very closely linked to the surrounding catchment in terms of both impacts on the farm, and impacts of the farm on the external environment. A schematic overview of the concepts is given in Figure 1.

More detail on the catchment approach, the risks and appropriate actions is given in the associated SAI document: *Beyond the farm towards a catchment approach* (SAI Platform 2013).

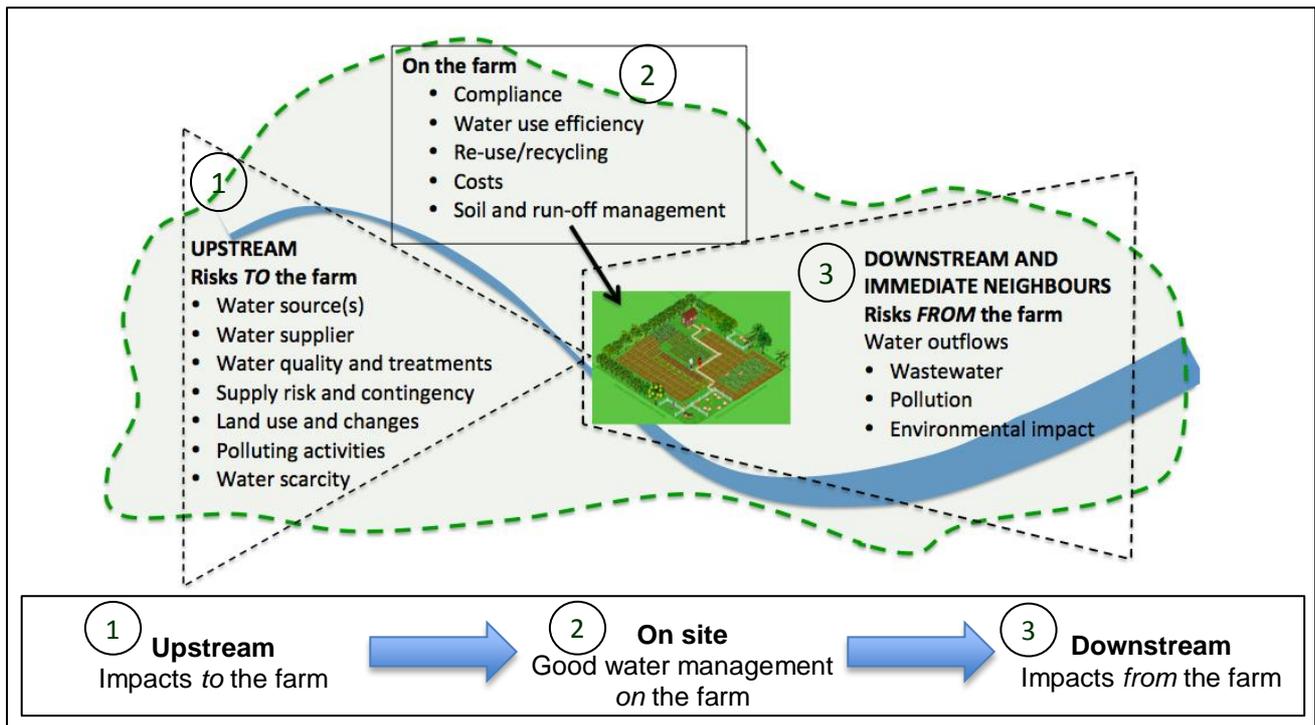


Figure 1 Understanding water related risks in a catchment context

3. Knowledge requirements

A water stewardship programme must be preceded by risk assessment. To complete a reliable risk assessment, a basic level of knowledge is required on water supply and management at the farm level. This section describes the basic and more advanced levels of relevant knowledge. Much of this knowledge will require some specialist expertise to gather the right information, to know where to look for it, and to do the analyses. Those marked with * will almost certainly require specialist support.

1. **Characteristics of the farm.** Define the basic characteristics including location, size, crops and/or livestock and production volumes.
2. **The catchment*.** On a map, mark out the boundaries of the farm and the relevant catchment (which may be a full or sub-catchment, depending on scale).
3. **Volume of total water use.** Annual average, and future requirements (eg. at 10 years). Also describe seasonal variations. Distinguish between 'consumptive' (net water use) and 'non-consumptive' water use (water returned unchanged to the local water cycle).

4. **Water sources.** Identify all water sources, whether surface water or groundwater, or special source, such as captured rainwater. Mark these on the farm/catchment map. Identify the owner of each source, whether the farm itself or another (which could be a neighbouring landowner or commercial water supplier). Describe the characteristics of each source (eg. borehole construction, depth and age) with diagrams as appropriate. For municipal supplies, identify the supplier, and basic information on its water sources, infrastructure and storage facilities.
5. **Water uses and volumes.** Record every purpose for which water is used, the requirements for each use (annual and/or seasonal), and which source(s) supply it.
6. **Water treatment.** Describe any water treatment applied and its purpose.
7. **Water storage facilities.** Describe type, capacity and purpose. Mark on map.
8. **Wastewater.** Record all wastewater streams, any treatments (if applicable), and where it goes. Mark on the farm/catchment map. Record volumes.
9. **Uncontrolled water discharges.** Record points where significant run-off is concentrated (whether during normal operation or storms). Identify the nature of the run-off (eg. from rainfall or wash-down areas), its origins (eg. cropped fields, livestock areas) and its destination (eg. storm drain, surface water body, drainage ditch). Note any buffers before the receiving water body (eg. buffer strips, reedbed treatment).
10. **Regulatory agencies.** Record all authorities or agencies responsible for water and wastewater, and their key contacts.
11. **Permits.** Record all permits related to water abstraction, water use and wastewater, and their conditions (eg. abstraction rates, wastewater quality limits). Verify compliance.
12. **Catchment water users.** Identify other water users in the defined catchment area. As much as possible, define who they are, nature of their business, location and nature of water source(s), volumes used (or permit limits). Mark on map. In particular, identify those who rely on the same water source or water bodies.
13. **Catchment land use*.** Map general land use across the catchment. Identify in particular, High Conservation Value (HCV) areas, especially those linked with water. Also, industrial sites, urban areas, mines, or anything that could be associated with high water use or water pollution.
14. **Catchment conceptual water cycle model*.** With the help of appropriate drawings (map and cross-section), describe the basic water cycle of the catchment, to include precipitation, run-off, infiltration, evaporation, main water throughflows (rivers, groundwater), main water users and main points where water leaves the catchment.
15. **Water balance*.** A quantification of the inflows, throughflows and outflows of a system (including evapotranspiration, abstractions and discharges), which should sum up (at least approximately). There should be two levels of water balance assessment: one for the farm, and one for the catchment (or sub-catchment). The catchment conceptual model is important to help identify the main flow components. See SAI (2013) for more explanation.

4. Risk assessment

4.1. Risks to the farm

Understanding risks **to** the farm is a key part of the business case for water stewardship. Knowing the risks puts the farm in a better position to reduce, mitigate and manage them. Potential business impacts include unexpected costs, loss of production and failure to supply customers on time, which can damage customer confidence. In the worst cases, severe risks such as drought or flood can destroy the farm as an ongoing business. Where risks are

identified as 'low risk', this increases business confidence for owners, customers and investors.

The main risks to the farm to consider, with examples of appropriate actions and mitigation, are given in Table 1.

Table 1 Examples of risks TO a farm

Risks to consider	Action	Mitigation options depending on cause and expert recommendations
1. Water quantity		
Falling groundwater levels making it harder or more costly to abstract	Technical studies to find the cause	Find ways to reduce water use; find alternative sustainable water sources; work with stakeholders for catchment wide solution.
Boreholes in a poor condition and in danger of collapse	Inspections by specialist contractor	Renovate or replace
No additional water supply capacity (either physical or regulatory) for business growth	Expert studies. Engage with regulators.	Improve efficiency; develop new sources; permit trading; revise business plans; change to less thirsty crops
Projected increase in water scarcity or frequency of droughts	Expert studies. Engage with regulators on their policy plans.	Improve water efficiency; change to more drought tolerant crops.
2. Water quality		
Polluting activities near to water sources	Monitor water quality and trends.	Move pollution source; protect or move water source; engage with polluter to agree mitigation
Negative quality trends in water sources such as salinity or chemical pollution.	Studies to identify cause and potential solutions.	Move pollution source; protect or move water source; engage with polluter to agree mitigation
3. Flood risk		
The farm is located wholly or partially on a flood plain	Studies to know likelihood of occurrence, scale and areas at risk	Protect or move water sources; ensure contingency and/or emergency supply
Changing land use in upper catchment increases flood risk (eg. deforestation, urban development)	Studies to understand how risk is changing	Engage with catchment stakeholders to agree actions to reduce risk; on-site mitigation
4. Regulatory risk		
Breach of permit conditions (eg. for abstractions, wastewater discharges)	Determine whether breaches are regular, occasional or becoming more common, and whether a relaxation in permit conditions can be justified (expert study).	Reduce water use; develop new lower risk sources; introduce wastewater treatment; apply for a relaxation of permit conditions (where justifiable)
Future restrictions on water supply are planned to protect the natural environment or mitigate projected water scarcity	Engage with regulators to understand their policy plans and to protect the farm's interests as appropriate	Improve water efficiency; change crop type or variety; engage with stakeholders for common solutions.

4.2. Risks from the farm to others and the natural environment

Understanding the risks **from** the farm is essential to protecting reputation and to address the wider principles of corporate water stewardship, which in turn may be important for maintaining the trust and respect of customers.

The main risks *from* the farm to consider, with examples of appropriate actions and mitigation, are given in Table 2.

Table 2 Examples of risks FROM a farm

Risks to consider	Action	Mitigation options depending on cause and expert recommendations
1. Water quantity:		
Excessive water abstractions may have a negative impact on other water users, the natural environment or water-dependent HCV areas.	Expert studies to determine likelihood, nature and scale of impacts	Improve water efficiency; move water sources; work with stakeholders to find solutions
2. Water quality		
Run-off from fields may carry fertiliser residues (nitrates and phosphates) into nearby streams, causing eutrophication, which deprives natural species of oxygen	Studies and monitoring to understand scale of problem	Modify how fertilisers are used; modify land and crop management; create buffer strips; create wetland treatment systems
Pesticide and fertiliser residues may be transported by run-off to contaminate surface water and groundwater, and potentially drinking water sources.	Studies and monitoring to understand scale of problem	Modify how pesticides and fertilisers are used; modify land and crop management; create buffer strips; create wetland treatment systems
Poor land and crop management may result in excessive amounts of soil and silt flushing into streams after rain causing problems for fish and other sensitive species.	Studies and monitoring to understand scale of problem	Modify land and crop management; create buffer strips; create wetland filtering systems
3. Flood risk		
Removal of native vegetation, building on flood plains and straightening water courses may increase the flood risk for others downstream.	Studies to assess the impacts of any changes	Apply appropriate and feasible mitigation measures
4. Wastewater		
Poorly managed or untreated wastewater may contaminate water bodies and impact on other water users	Confirm how wastewater is managed. Studies to assess impacts	Ensure no negative impacts beyond compliance

REFERENCES

FAO (1986), Irrigation Water Management: Irrigation water needs, Training manual no. 3.
Authors C. Brouwer and M. Heibloem

<http://www.fao.org/docrep/s2022e/s2022e00.htm#Contents>

SAI 2012, Water Conservation Technical Briefs, TB-15 Drip irrigation and water scarcity

<http://www.saiplatform.org/uploads/Modules/Library/sai-technical-brief-15-drip-irrigation-and-water-scarcity-2.pdf>

SAI 2013, Water Stewardship in Sustainable Agriculture: Beyond the farm towards a catchment approach

<http://www.saiplatform.org/uploads/Modules/Library/sai-platform-water-stewardship-report.pdf>

GLOSSARY

Aquifer: Geologic formation containing sufficient water and permeability to yield significant quantities of water to springs, wells and boreholes.

Borehole: A mechanically drilled or excavated vertical hole from the surface, usually into an aquifer for water abstraction. Typically of 20 to 30 cm diameter and 10s to 100s of metres deep. Lined with steel or plastic tubes for stability. Tubes are perforated within water bearing rock (where the rock is not rigid enough to stay open unsupported). See also 'water well'.

Catchment: Area of land from which all surface run-off flows through a sequence of streams, rivers, aquifers and lakes into the sea or another outlet at a single river mouth, estuary or delta. A catchment can be divided into smaller units: 'sub-catchment' or 'sub-basin'.

Consumptive water use: Water used, but not returned unchanged to the original source or local water cycle.

Eutrophication: Process by which water is enriched with plant nutrients, most commonly phosphorus and nitrogen, often leading to excessive algal growth and oxygen depletion.

Evaporation: The evaporation of water directly from water surfaces and the soil.

Evapotranspiration: The total of evaporation plus transpiration. **Transpiration** is the process by which water passes through living organisms, primarily plants and their leaves, and vaporising into the atmosphere.

Fossil water: Water that infiltrated millennia ago, and stored underground since that time, and no longer naturally renewed or replenished.

HCV (High conservation value) area: Area designated to be of high biological, ecological, social or cultural value, such as a nature reserve, of local, regional or national importance. Many, such as wetlands, are dependent on high quality natural water bodies.

Non-consumptive water use: Water used, but which is returned to the original source or local water cycle at an equivalent or better quality.

Water stewardship: The use of freshwater that is socially equitable, environmentally sustainable and economically beneficial, achieved through a stakeholder-inclusive process that involves site-and catchment-based actions. Good water stewards understand their own water use, catchment context and shared risk in terms of water governance, water balance, water quality and important water related areas.

Water well: An excavated or hand-dug hole in the ground into water bearing soft or hard rock, usually for domestic or other small scale water abstraction. Supported with brick, stone, wood or metal walls, usually not more than a few metres deep. The term may also include boreholes in everyday speech. See also 'borehole'.

APPENDICES

Appendix 1 Sources of water

Appendix 2 Global tools – the value and limitations

Appendix 3 Influences on water requirements

Appendix 4 Linking to the Farmer Sustainability Assessment

Appendix 5 Water risk assessment indicator model

Appendix 1 Sources of water

This appendix lists most common sources of water for agriculture.

Rainfall. Many crops rely entirely or partially on rainfall. According to FAO, 60% of world food produce is rainfed. In individual countries it can range from less than 5% to nearly 100% of water supply to agriculture. Rainfall may directly infiltrate the soil, or maybe harvested and stored for later use.

Surface water is abstracted from rivers, streams, lakes or ponds. It is either pumped to the point of storage or use, or diverted, for example for flood irrigation. It does not normally require treatment for irrigation or livestock, but treatment is usually required for high quality uses such as for drinking water or food processing.

Groundwater is mostly abstracted from wells and boreholes from water-bearing geological layers (aquifers). Boreholes have liners and filters to depths of 10s or even 100s of metres (called tubewells in India). In some regions of the world, groundwater is 'fossil water' meaning it is no longer replenished due to past climatic changes. Water direct from a spring is a natural source of groundwater. Groundwater is usually of very high natural quality, due to the filtering action of the rocks, requiring little or no treatment for most uses.

Municipal supply. Some farms, mainly limited to developed countries, have access to a municipal water supply. It is usually limited to high quality uses such as domestic and food processing. Its cost means it is not generally suitable for large volume uses such as irrigation. Municipal water sources may be surface water or groundwater, and sometimes desalinated water.

Large scale irrigation schemes. In some regions, farms have access to large scale irrigation schemes, dedicated to agriculture, often funded or subsidised by governments. The infrastructure may include dams and canals for transport and distribution of water. The sources of raw water may be surface water (often diverted from rivers) or groundwater, and normally untreated at point of supply.

Treated wastewater. In water scarce regions, wastewater (domestic and/or industrial) is sometimes used to irrigate crops. While untreated wastewater is sometimes used, it is best practice, and highly recommended to ensure the wastewater is treated to a quality that is safe, for farm workers, for use on food products and for the natural environment. Treated wastewater may also be used to replenish aquifers dedicated to water abstractions for agriculture.

Appendix 2 Global tools – the value and limitations

There are a large number of global water risk assessment tools freely accessible online (often with requiring registration) or downloadable. Lists and reviews are available, for example:

- The WBCSD (World Business Council for Sustainable Development) review of 18 tools and standards in its report 'Water for Business' (2012):
<http://www.wbcsdpublications.org/viewReport.php?replD=267>
- The WWF Water Risk Filter website provides a link to download a tabulated review and comparison of 12 tools: <http://www.waterriskfilter.panda.org/en/KnowledgeBase#10>

Each tool has advantages and limitations, and may be suited to certain industry or agricultural sectors. Examples of advantages and limitations are given below.

Advantages of global tools (common examples):

- Free
- Provide an overview and awareness of the range of external water-related risks
- A first pass assessment of the potential level of risk at a given geographical location
- A tool for comparing risk rating between multiple sites in different locations

Limitations of global tools (common examples):

- Resolution is regional, or at best catchment level. They cannot focus on specific sites for which conditions may be better or worse than the average of the larger geographical unit.
- Database vs local knowledge and expertise. Interpretations are based on global databases of a limited range of information types, mainly climate related, some with additional details such as population density and crop type, and some requiring site specific data. However, they cannot take account of all local level information, which requires local research and assessments.
- Snapshot. Global databases represent a snapshot of the time when data were last collated, and cannot take into account more recent changes or events.
- Geological and hydrogeological knowledge is incomplete in many regions, especially in developing countries. Local research and on-the-ground studies are often required.

Examples of how global tools can be inadequate or misleading on a site-specific scale:

- The tool indicates a **high** water scarcity risk in a region based on annual average rainfall and population. In reality, the farm overlies a plentiful aquifer replenished by rainfall many kilometres away in a non-water scarce region. **The real water scarcity risk is low.**
- The tool indicates **low** water scarcity risk in a region based on abundant annual rainfall. In reality, a high concentration of abstractions for agriculture and industry has created a local and severe decline in groundwater levels. **The real water scarcity risk is high.**
- A global tool cannot, for example, identify:
 - A failing borehole
 - Regulatory risk (eg. new restrictions on abstraction permits)
 - A recent and critical drying up of a wetland due to over-abstraction
 - The existence of a polluting industry near to a water source
 - That the water supply infrastructure (eg. municipal supply or irrigation scheme) is at capacity and requires significant investment to expand

In conclusion, global water risk tools have an important role in water stewardship. They raise awareness about common issues and trends, provide a first pass assessment of potential risks, and help with comparisons between multiple sites. However, they cannot identify actual risk at specific sites or define specific actions to address and mitigate risk. This requires local assessment with specialist support, and local knowledge and research.

Appendix 3 Influences on water requirements

Many factors influence water requirements in agriculture, as in the following examples.

Irrigation efficiency and scheduling

- Flood irrigation is inefficient. In water abundant regions, there may be little concern. In some cases, the 'lost' water may benefit nearby farmers or the natural environment.
- Drip irrigation improves water efficiency. See SAI Technical Brief TB15 (SAI 2012)
- Irrigation scheduling improves efficiency, for example, by avoiding hours when evaporation rates are highest, not irrigating close to periods of rainfall, and using soil moisture sensors to optimise irrigation scheduling and amounts.

Crop variety

- Different crops have a wide range of water requirements (see chart below)
- Different varieties of the same crop may have different water requirements. New 'drought resistant' varieties have been, and are being developed for many crops.
- The ideal is to match crop and variety with local climate and irrigation options.

Soil condition and health

- Type of soil influences water requirements. Sandy soils retain little water, allowing it to seep quickly to below the root zone. Sandy soils, therefore, require higher rates of irrigation. Soils with clay and high organic retain more water. Too high a clay content can lead to water logging and potentially salinization.
- Poor soil management may result in loss of condition and its water retention properties.

Climate and season

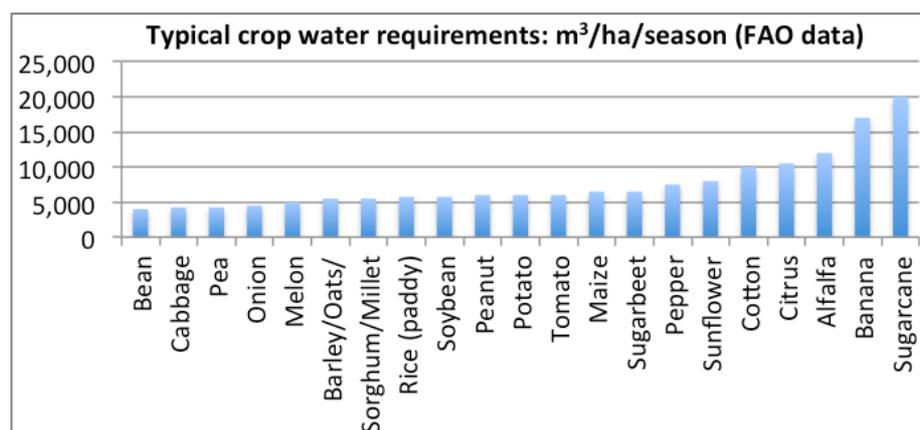
- Water requirements depend on evaporation rates (dependent on sunshine hours, ambient temperatures and wind). In a region with higher evaporation, less water is left available for crops for the same rates of rainfall or irrigation.
- A crop with a longer growing season may require more total water even if its daily requirement is less.

Land slope and ploughing

- Flatter land allows less run-off and gives incident water more chance to infiltrate the soil.
- Terracing helps achieve this aim, while also reducing soil erosion.
- Plough lines across slopes retain more water (and soil) than plough lines up/down slope.

Livestock

- Water requirements range from < 1 l/d to >60 l/d per individual, depending on species, climate and other conditions.
- In tropical and temperate climates, livestock get most of their water from natural sources: streams, ponds and their food. Additional water may be required in dry seasons.
- In drier climates, water must be provided more regularly, sometimes for 100% of needs - often the case for commercial livestock farming in arid climates.
- The ideal is to select livestock adapted to the climate conditions. Indoor temperature controlled environments may offset this, but of course, with higher energy requirements.



Appendix 4 Linking to the Farmer Sustainability Assessment

This appendix highlights all FSA questions for which good water management is relevant, with a short explanation of the context. (For FSA ver 2.0)

FSA Topic	Code	Subject	Relation to site-specific water risk assessment
Legal compliance	FSA1 to FSA3	General	Be compliant with permit conditions. Be informed of upcoming policy and regulatory changes.
Financial stability	FSA4 to FSA7	General	Business sustainability is dependent on long term availability of water, especially for business growth. Rising water supply costs will impact on business.
Farm management	FSA8 to FSA12	General	A water management plan should be integral to farm management, including impacts on soil and land.
Planting	FSA13	Crop selection	Avoid using thirsty varieties in water scarce geographies.
Soil management	FSA20	Soil erosion	Water is the main cause of soil erosion. Apply best practices.
Nutrient management	FSA29	Safe storage of fertilisers	Store to avoid contamination of water sources and water bodies.
Crop protection products	FSA39	Application	Poor application practices increase the risk of water contamination
	FS41	Safe storage	Store to avoid contamination of water sources and bodies
Agro-chemicals	FSA42	Non-target areas	Protect water sources surface water and groundwater from poorly targeted use.
	FSA44 to FSA46	Storage, cleaning, disposal	Avoid contamination of water supplies and water bodies
	FSA49	Spills	Emergency measures should include protection of water sources and water bodies.
Waste management	FSA51	Waste storage	Store to avoid contamination of water sources and bodies
Water Management	FSA53	Irrigation water quality	Poor irrigation water quality may impact on crop growth and health
	FSA54 to FSA55	Irrigation efficiency	Apply best practice to optimise water use and reduce waste water. Include in management plan.
	FSA56	Compliance - Quantity	Where required, ensure you have and comply with permits
	FSA57	Irrigation method	Use optimised methods and re-use/recycle where possible
	FSA58	Compliance - Quality	Ensure compliance with irrigation water quality regulations, especially for food safety
	FSA59	Wastewater and chemicals	Manage wastewater to avoid pollution of water sources and bodies
	FSA60	Run-off areas	Manage run-off areas (from washing or rain) to avoid contamination of water sources and bodies
	FSA61	Buffer zones	Use buffer strips and zones to protect surface water bodies from contamination by chemicals, waste and soil
	FSA62	Irrigation records	Record dates, quantity, quality, location, purpose, origin
Biodiversity	FSA63 to FSA68	General	Biodiversity may be at risk from water abstractions and pollution. Include biodiversity in risk assessments and water management plans. Use buffers zones where appropriate.
Market access	FSA74 to FSA76	Food safety and quality	Contaminated water (for irrigation, washing, processing) may put food safety at risk, and also reputation.
Health and safety	FSA108	Access to safe drinking water for employees	Water for drinking, food preparation and washing must be sufficient, safe and compliant.

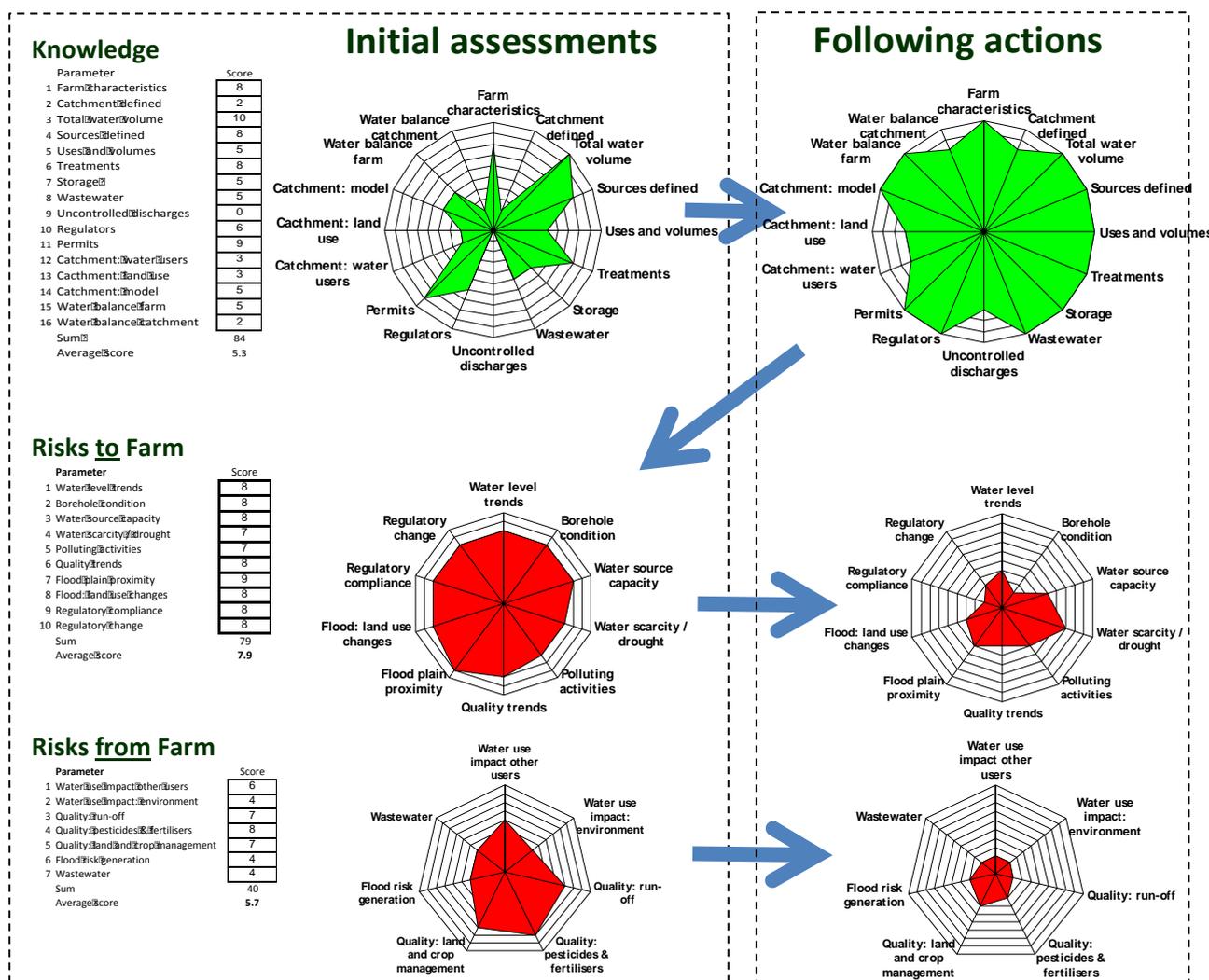
Appendix 5 Water risk assessment indicator model

A model for water risk assessment indicators is proposed. Key steps towards achieving farm and catchment level water stewardship are: knowledge, risk assessment and mitigation, as described in Sections 1 and 2.

The model provides a clear visual representation of the level of knowledge achieved, and the level of risk through three radar charts representing: (i) Knowledge, (ii) Risks To Farm, and (iii) Risks From Farm. The chart also shows clearly where to focus knowledge gathering or risk mitigation.

- (i) Knowledge Indicator Chart. The principal is that a certain level of knowledge is required before a reliable risk assessment can be made. Less knowledge of a parameter gives a lower score and less 'green'. First, generate the radar chart based on initial level of knowledge. The result helps identify where to focus data collection and research, with the aim of maximising the score and amount of 'green'.
- (ii) Risks To Farm Indicator Chart. Generate the chart based on the initial risk assessment. A higher risk gives a higher score and more 'red'. Use the results to target risk mitigation. Then regenerating the chart should result in lower scores and less 'red'.
- (iii) Risks From Farm Indicator. This follows the same principle as for Chart (ii).

The radar charts are a standard chart option in Excel. Each parameter gets a score between 0 and 10. For Knowledge, 0 is bad, 10 is good. For Risk, 0 is good, 10 is bad. The eventual aim is to maximise the Knowledge: scores, and to minimise the Risk scores. The average score for each chart can also be a useful indication of overall status. This is a model that should be quite easy to tailor to specific site settings and characteristics.





The Sustainable Agriculture Initiative is a food industry organization aimed to support the development of sustainable agriculture involving stakeholders of the food chain

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