

Managing Invasive Aquatic Plants

Note in response to the request from the UN Resident Coordinator’s Office in Côte d'Ivoire, focussing on the Yamoussoukro lakes

Table of Contents

1	Key challenges and solutions to managing invasive aquatic plants	1
2	The situation in the Yamoussoukro lakes	3
3	Recommended next steps to address aquatic invasive weeds in the Yamoussoukro lakes	4

1 Key challenges and solutions to managing invasive aquatic plants

1.1 Challenges and impacts

Aquatic invasive plants (weeds) are a widespread global problem with potentially severe impacts on local aquatic ecosystems. Ecological and socioeconomic impacts are generally brought about by a loss of ecosystem function and services. The more ‘aggressive’ aquatic weeds typically spread very fast (e.g. can double in mass every [1-2 weeks](#)), and have limited, if any, natural predators in their new environment to keep them under control. Impacts typically include the [following](#):

- **Ecological:** weeds can destroy wetlands and waterways, potentially killing native fauna (e.g. fish and other wildlife) and flora (e.g. native aquatic plants). This happens because they change the natural balance of the ecosystem, including blocking sunlight and depleting oxygen levels;
- **Social:** weeds can increase water loss (up to [three times higher](#) than regular evaporation), and provide a breeding ground for mosquitos and other pests. Due to their covering the water surface, and limiting access to water bodies from the shore, they can result in loss of cultural, recreational, and aesthetic value.
- **Economic:** weeds can result in a loss of income from fishing; impacts on operation of, and damage to, infrastructure (e.g. irrigation schemes, hydropower, drainage); loss of access to water for livestock; and loss of tourism revenue.

1.2 Root Causes

To manage the spreading of aquatic invasive weeds, it is important to understand the root causes.

Clearly, a critical cause is the ‘introduction’ of the species to the area. Often, an introduced species may have been imported to an area for aesthetic value, which then ‘escapes’ into natural habitats. Seeds can also be introduced unwittingly by humans and sometimes by birds or other animals.

However, there are a range of catchment-based circumstances that can affect how likely the weed is likely to establish itself, and how fast it proliferates. Mostly, these relate to raised levels of organic materials (nutrients) entering the waterbody, which can come from a range of sources, including: poor agricultural practices, including over-application of fertilisers (i.e. non-point sources) and pollution from commercial livestock waste (i.e. point sources); land use changes such as urbanisation and conversion of natural habitats to agricultural land, both of which can increase run-off and change flow patterns; and commonly from untreated wastewater from commercial, industrial, and residential areas.

1.3 Solutions

There is usually no ‘quick fix’ to a severe aquatic weed problem. Rather, an integrated and holistic approach is needed that addresses the key challenges, impacts and root causes mentioned above.

A management cycle may include:

- scoping study (e.g. rapid assessment) to understand the severity of the infestation, types of weeds, potential root causes, key stakeholders, and the need for further analysis;
- engage with key stakeholders; deeper analysis as required; develop management options and co-design a management plan;
- identify and secure funding; implement the management plan; and monitor and review.

Depending on the severity of the challenge, and local circumstances, effective solutions will typically involve many of the actions listed below (i.e. solutions usually won’t work if implemented in isolation).

Addressing the root causes: integrated catchment management

If the root causes are not addressed (see 1.2), it is unlikely that any ‘on-site’ actions (see below) will be effective in the long-term. It is therefore important to understand the root causes through a dedicated analysis. This may include a field survey of the waterbodies and surrounding catchment, modelling, and/or use of remote sensing images.

Immediate/on-site remediation: typically, remediation involves a combination of [all three types](#)¹:

- **Physical removal:** physical barriers, manual removal, mechanical removal. Need to manage removed weeds (e.g. in case of heavy metal pollution).
- **Biological control:** e.g. weevils, moths, fungal pathogens. There have been many successful schemes, but extreme caution must be applied to ensure impacts are targeted and not introducing a new problem (Success stories: [Benin](#), [South Africa](#)).
- **Chemical control (herbicide):** can be effective in the short-term, with careful application, depending on the size of the infestation. Need to be aware of long-term / other impacts of chemical use.

A note on deriving ‘value’ from aquatic weeds: Over the past several decades, attempts have been made to use the weeds for beneficial purposes, including as a material, fuel, or fertiliser. However, despite extensive research and trials, it has proved very difficult to identify replicable and commercially viable uses of aquatic weeds. Furthermore, by attempting to extract value from the weeds, there is the potential to create perverse incentives to keep the weeds, with ongoing ecological and other impacts. Therefore, this particular management option is not generally recommended, with ‘control’ options above preferred, though it may be part of an integrated solution.

¹ Success stories: a [summary](#).

2 The situation in the Yamoussoukro lakes

This section contains a summary of the 2021 CIAPOL report on the assessment of the state of 14 Yamoussoukro lakes (11 artificial and 3 natural)², followed by reflections on limitations of the report.



Summary of key issues in and around the lakes (from the CIAPOL report)

- Weed coverage ranges from partial (5 lakes) to total / almost total (9 lakes), with average height of biomass estimated at 0.5m. Shorelines of lakes mostly completely overgrown.
- Type of weeds: sacred lotus (*nelumbo nucifera*³, roots in bottom) (all lakes), water hyacinth (2 lakes), tall grasses / reeds / shrubs. Banana plants on 4 lakes.
- Weeds rooted to the bottom (likely making them more difficult to remove mechanically)
- Pollution: sewage (in most lakes) and macro waste (in some)
- High number of crocodiles and caimans in lakes 1-4 (“thousands”)
- Damaged connecting culverts and concrete slabs around many of the lakes
- Siltation
- Cultivation of market gardens by local residents on lakes 8 and 9.

Summary of key catchment related issues (root causes) (from the CIAPOL report)

- Untreated wastewater, and polluted runoff, from surrounding urban area.
- The canals that lead to the lakes show high eutrophication (increasing the proliferation of the weeds).

Recommended actions in the CIAPOL report mainly consist of ‘restore the lake and surroundings’ and ‘clean surroundings’, with relatively little information on what the restoration and cleaning would entail and how to go about it. The report recommends certain actions before weed removal is carried out, including: isolate crocodile populations; civil engineering works around certain lakes to restore surrounding infrastructure (slabs) and culverts; create access roads to allow machinery to access the lakes (e.g. dredgers and amphibious mowers).

Further recommendations from the report include:

- Carry out a bathymetric study to establish the depth of the lakes;
- Acquire machinery (at least two amphibious mowers with a capacity to collect ½ ha of plants per day; trucks with 10m³ capacity)
- Identify and secure a site for the removed biomass.

There is also an estimation of days needed for mechanical removal of weeds from each lake (from which costs could potentially be derived), and costs estimates for truck removal of the biomass (USD ~1.5mill.).

² Prospection de l'état d'invasion et proposition des mesures de restauration des lacs de Yamoussoukro (2021). Centre Ivoirien Antipollution (CIAPOL). Photos in this note are taken from that report.

³ It should be noted that the literature on controlling sacred lotus (*nelumbo nucifera*) is relatively sparse, compared to other aquatic weeds such as water hyacinth. Therefore, further assessment is likely to be required to confirm the various species of plants, to inform management options.

Reflections on the CIAPOL report – what more do we need to know?

- Overall, the report is very descriptive of the location and surface area of the lakes, and the severity of the problem in and around each lake, noting some critical challenges to remediation. However, the recommendations for restoration do not take a starting point in addressing root causes and does not follow an integrated approach, as described in [section 1.3](#) of this note.
- Of the 3 types of onsite control, the report only mentions physical removal (mechanical), which is rarely effective or long-lasting when it is the only control measure undertaken. Chemical (herbicide) and biological (e.g. weevil) control should be considered. For chemical control, note specialist assessment and training is required for application. For biological control, note further specialist assessment and studies required, likely leading to a longer timeframe before initiating action. Caution needs to be applied to both control options, to avoid unintended negative consequences.
- Catchment considerations:
 - a. No mention of reducing pollution sources, namely sewage (unclear if there is direct discharge into some of the lakes), runoff, and macro-litter. Addressing these would have several other social and environmental benefits.
 - b. No mention of consideration of upstream pathways for the weed getting to the lakes.
 - c. No mention of consideration of upstream and surrounding land-use impacts.
- Need for stakeholder analysis: those that might be involved in mitigation, those that might be impacted/benefit from addressing the weed infestations (on-site and catchment activities). Also, the need for awareness raising, behaviour change and stakeholder involvement is missing.
- Need for more detailed recommendations on next steps, including roles and responsibilities, potential partners, what further analysis is required, and potential funding sources.

3 Recommended next steps to address aquatic invasive weeds in the Yamoussoukro lakes

It is recommended that a ‘rapid integrated assessment’ should be the next practical step in addressing the invasive aquatic weeds in the Yamoussoukro lakes and surrounding catchment. The rapid assessment would build on the CIAPOL report.

A rapid integrated assessment may include the following:

- Root-causes analysis: i.e. catchment assessment, including sources of pollution/nutrients, wastewater treatment levels, land-use changes, urban development related drivers of change, and climate change impacts.
- Updated assessment of the situation in and immediately around the lakes (update on the main content of the CIAPOL assessment, undertaken June 2021).
- More detailed analysis/research on most effective remediation actions on the specific weed-types present.
- Stakeholder analysis: those impacted and those who may have a role in remediation/management (stakeholder groups may be in both categories). This may include a capacity needs assessment of potential implementing authorities (e.g. institutional and technical capacity and supporting regulatory frameworks). Develop stakeholder engagement plan (defining roles, etc.).



- Support the development of an integrated management plan, containing: remediation options including on-site (physical, chemical, biological) and catchment (e.g. pollution sources) activities; cost-benefit analysis of options, including timeframes; potential key partners and sources of funding. The integrated management plan is likely to include different phases, e.g. short-term ('quick' action to get on top of the problem); medium-term (e.g. containment, need for ongoing management (e.g. dealing with seed-banks and nutrient sources)); long-term (e.g. monitoring and management).

Timeframe and budget

The rapid assessment may be undertaken through a combination of a field visit(s) and desktop analysis. The approximate timeframe could be approximately 6-9 months, with a budget of approximately USD 100-125k.

Following the rapid assessment, further consultation would take place with key stakeholders to discuss the recommendations from the report, and agree on next steps. This would lead to the development of a proposal, and securing funding.

The next phase would likely involve finalising the draft integrated management plan, including more detailed analysis and prioritisation of options based on some form of Decision Support System (DSS) / Multi-Criteria Analysis (MCA), followed by implementation.

Potential implementing partners

The rapid assessment could be undertaken in partnership between the UN and relevant government agencies, in support of the UN Sustainable Development Cooperation Framework 2021-2025. On the UN side, the key implementing partner could be the UN Environment Programme (UNEP), as part of the UN Country Team under the direction of the UN Resident Coordinator. On the government side, this would likely be led by the Ministry of Environment and Sustainable Development, Ivorian Anti-Pollution Centre (CIAPOL), sub-directorate on management of polluted sites and fight against invasive aquatic weeds (GSP-VAE).

UNEP has the experience and technical capacity to undertake such a rapid assessment, in particular through the [UNEP-DHI Centre on Water and Environment](#) (see box 1). Moving forward, UNEP also has Earth Observation expertise (including through the Freshwater Ecosystems Explorer ([SDG661app](#)) (see below), and Cascade), which could be used to monitor the existence of weeds in the lake (and therefore the impact of the management actions) (see below).



Fig. a): lakes schematic from CIAPOL report



Fig. b): Wetlands extent (vegetated) from [SDG661app](#) (HydroBasins layer 6, basin 145405, NE area of basin)

Box 1: UNEP’s rapid integrated assessment in Kenya

At the request of the Technical Committee for Water Security in the Arid and Semi-Arid Lands (ASAL) Regions of Kenya, UNEP-DHI conducted a rapid integrated assessment of water resources in 10 ASAL counties. The study identified key challenges and opportunities to build water security in the region so as to inform future interventions. The report included 9 high-level recommendations for improving water security, spanning three areas: improvement of physical infrastructure, governance arrangements, and data. The recommendations contributed to the development of a proposed “UN Joint Programme for Sustainable Integrated Water Management for enhanced Health, Food security and Climate-resilient livelihoods in Kenya’s arid and semi-arid lands (ASAL) and other fragile ecosystems”, as a contribution to Kenya’s 2022-2026 Cooperation Framework (available on request). Source: UNEP-DHI Centre 2022, [project description](#).

Additional references

- Nelumbo nucifera (sacred lotus) [factsheet](#) (Wisconsin, USA, approx. 2011). NB “Control: undocumented”.
- Sacred Lotus [overview](#) (Wisconsin, USA)
- Nelumbo nucifera (sacred lotus) [factsheet](#). CABI 2021.
- Water Hyacinth Control [Factsheet](#) (2020) and [Control Modules](#) (2013), Australian government.
- [UNEP Global Environmental Alert Service \(GEAS\)](#). Water Hyacinth - Can its Aggressive Invasion be Controlled?
- Fadoua et. al. (2022). A Comprehensive Evaluation of the Existing Approaches for Controlling and Managing the Proliferation of Water Hyacinth (Eichhornia crassipes): Review. <https://www.frontiersin.org/articles/10.3389/fenvs.2021.767871>