Towards Sustainable Phosphorus Cycles in Lake Catchments (uP-Cycle)

Part I: Project Information

GEF ID
10892

Project Type
MSP

Type of Trust Fund
GET

CBIT/NGI
CBIT **No**
NGI **No**

Project Title
Towards Sustainable Phosphorus Cycles in Lake Catchments (uP-Cycle)

Countries
Global, Chile

Agency(ies)
UNEP

Other Executing Partner(s)
The UK Centre for Ecology and Hydrology (CEH) in collaboration with the Chilean Ministry of Environment

Executing Partner Type
Others

GEF Focal Area
International Waters

Taxonomy
Freshwater, International Waters, Sustainable Land Management, Land Degradation, Focal Areas, Influencing models, Stakeholders, Gender Equality, Gender results areas, Capacity, Knowledge and Research, Chemicals and Waste, Pesticides, Sustainable Development Goals, Sustainable Agriculture, Ecosystem Approach, Pollution, Nutrient pollution from Wastewater, Nutrient pollution from all sectors except wastewater, Persistent toxic substances, Lake Basin, Learning, Acquaculture, Large Marine Ecosystems, Transform policy and regulatory environments, Convene multi-stakeholder alliances, Strengthen institutional capacity and

decision-making, Demonstrate innovative approache, Private Sector, Civil Society, Academia, Community Based Organization, Non-Governmental Organization, Type of Engagement, Partnership, Consultation, Participation, Information Dissemination, Beneficiaries, Communications, Education, Behavior change, Gender Mainstreaming, Gender-sensitive indicators, Sex-disaggregated indicators, Awareness Raising, Capacity Development, Theory of change, Adaptive management, Indicators to measure change, Knowledge Generation, Workshop, Knowledge Exchange, Twinning, Innovation, Indigenous Peoples, Local Communities

Sector

Rio Markers
Climate Change Mitigation
Climate Change Mitigation 0

Climate Change Adaptation
Climate Change Adaptation 0

Duration
24 In Months

Agency Fee($)
190,000.00

Submission Date
10/12/2021

A. Indicative Focal/Non-Focal Area Elements

Programming Directions	Trust Fund	GEF Amount($)	Co-Fin Amount($)
IW-1-1	GET	1,000,000.00	7,800,001.00
IW-1-3	GET	200,000.00	2,013,843.00
IW-3-6	GET	800,000.00	5,600,000.00
	Total Project Cost ($)	**2,000,000.00**	**15,413,844.00**

B. Indicative Project description summary

Project Objective

To support lake ecosystems recovery through phosphorus emissions reductions from land to water to improve the protection and restoration of freshwater and coastal ecosystems, bringing together the global lake management and sustainable phosphorus management communities including developing and testing a sustainable phosphorus management framework in Chile to inform international application.

Project Component	Financing Type	Project Outcomes	Project Outputs	Trust Fund	GEF Amount($)	Co-Fin Amount($)

Project Component	Financing Type	Project Outcomes	Project Outputs	Trust Fund	GEF Amount($)	Co-Fin Amount($)
Component 1 Increasing clarity on global phosphorus emissions, drivers and impacts leading to increased awareness of global scale sector-specific phosphorus emissions reductions opportunities.	Technical Assistance	?**Outcome 1.1.** Global stakeholders have the evidence needed to assess the capacity for phosphorus emissions reductions to contribute to their commitments to delivering large-scale ecosystem restoration ambitions (e.g., the UN Decade and SDGs). Improved international and cross-sector awareness of the need for coordinated action to deliver large-scale phosphorus emissions reduction.	?**Output 1.1.1**. The Global Phosphorus Emissions Dashboard beta version developed and implemented as an open-source online mapping tool allowing visualization of emissions estimates and their contribution to eutrophication risk across the world?s large lakes, extending to coastal waters. **Output 1.1.2**. Two global stakeholder workshops demonstrating the Dashboard and inform discussions on cross-sectoral drivers of global phosphorus emissions to freshwater and coastal ecosystems, as well as opportunities to address them. **Output 1.1.3.** A White Paper outlining priority sector-specific actions towards delivering a	GET	304,546.00	2,049,234.00

Project Component	Financing Type	Project Outcomes	Project Outputs	Trust Fund	GEF Amount($)	Co-Fin Amount($)
Component 2. Building the Global Net Zero Phosphorus Community of Practice on sustainable phosphorus management in lake basins, producing the uP-Cycle Framework and Assessment Approach and accelerating its uptake to optimise emissions reductions programmes.	Technical Assistance	**Outcome 2.1.** Increased uptake of an international monitoring and assessment approach for the optimisation of phosphorus emissions reduction programmes leading to increased ambitions on the protection and restoration of lakes and their catchments and associated socio-economic benefits.	**Output 2.1.1.** Convene the Global Community of Practice on Sustainable Phosphorus Management in Lake Basins; a global network of practitioners tasked with assessing the global baseline on large-scale phosphorus emission reduction programmes. **Output 2.1.2**. Guidance materials leading to international implementation of the uP-Cycle Net Zero Phosphorus Framework and Monitoring and Assessment Approach, co-developed with the Global Community of Practice. **Output 2.1.3**. Global Baseline Assessment Report produced and shared with countries showcasing the first internationally coordinated assessment of present-day	GET	654,546.00	4,803,267.00

Project Component	Financing Type	Project Outcomes	Project Outputs	Trust Fund	GEF Amount($)	Co-Fin Amount($)
Component 3. Demonstrating the uP-Cycle Monitoring and Assessment Approach in Chile from basin to transboundary scales, in the context of enhancing existing policies.	Technical Assistance	**Outcome 3.1.** Improved understanding across Chilean government departments and its stakeholders on opportunities for enhancing phosphorus emission reduction programmes and policies, targeting protection of lake basins and the Humboldt Current Large Marine Ecosystem. *Outcome 3.1 will support delivery of core indicator 4: Area of landscapes under improved practices: 280,500 hectares of Lake Villarrica basin (lake Villarrica surface area ? 173km2) contributing to sub-indicator 4.1 .* *Outcome 3.1 will also*	**Output 3.1.1.** Produce a virtual surveillance portal integrating data streams to produce baseline and forecast outputs on phosphorus emissions and their impacts for the Lake Villarrica Basin, to inform the development of a national scale system. **Output 3.1.2**. Hold two Virtual Laboratory Workshops and produce targeted awareness-raising materials to engage stakeholders in the co-development and uptake of new opportunities for sector-specific emissions reductions at the lake basin-to national scales in Chile, utilising the surveillance portal. **Output 3.1.3**. A Transition Plan for Chile is published and shared across	GET	654,546.00	5,152,086.00

Project Component	Financing Type	Project Outcomes	Project Outputs	Trust Fund	GEF Amount($)	Co-Fin Amount($)
Component 4. Increasing integration of global sustainable phosphorus management opportunities across existing national, regional and global policy frameworks.	Technical Assistance	**Outcome 4.1** ? Improved national, regional, and global awareness of the benefits of integrating sustainable phosphorus management across existing policies within a coordinated approach (e.g., across World Water Quality Alliance (WWQA) and the Global Programme of Action (GPA); IPBES; IPCC; FAO, etc.).	**Output 4.1.1**. Documented project results disseminated through IW:LEARN activities (1% of the project budget) and established global initiatives. **Output 4.1.2.** Global communications plan to raise awareness across public, private and policy audiences, disseminated to IW:LEARN and established global initiatives. **Output 4.1.3.** The uP-Cycle Innovation Hub - a web-based information portal to accelerate the development and implementation of sustainable phosphorus initiatives. **Output 4.1.4** Publish and disseminate Global Policy Briefs to increase awareness across	GET	204,544.00	2,008,000.00

Project Component	Financing Type	Project Outcomes	Project Outputs	Trust Fund	GEF Amount($)	Co-Fin Amount($)
				Sub Total ($)	**1,818,182.00**	**14,012,587.00**

Project Management Cost (PMC)

GET	181,818.00	1,401,257.00
Sub Total($)	**181,818.00**	**1,401,257.00**
Total Project Cost($)	**2,000,000.00**	**15,413,844.00**

Please provide justification

C. Indicative sources of Co-financing for the Project by name and by type

Sources of Co-financing	Name of Co-financier	Type of Co-financing	Investment Mobilized	Amount($)
Recipient Country Government	Chilean Environmental Ministry	In-kind	Recurrent expenditures	156,000.00
Donor Agency	NL National Government	In-kind	Recurrent expenditures	138,000.00
Private Sector	Phoslock LTD	In-kind	Recurrent expenditures	55,200.00
Other	University of Edinburgh (LAC and Asia Office, Climate Change Institute)	In-kind	Recurrent expenditures	719,325.00
Recipient Country Government	Chilean Environmental Ministry	Public Investment	Investment mobilized	538,413.00
Donor Agency	UK National Government	Public Investment	Investment mobilized	4,653,360.00
Other	University of Edinburgh	Other	Investment mobilized	1,163,546.00
Civil Society Organization	WRI	Other	Investment mobilized	120,000.00
Other	University of Link?ping	Other	Investment mobilized	7,670,000.00
Donor Agency	World Bank	Other	Investment mobilized	200,000.00
			Total Project Cost($)	**15,413,844.00**

Describe how any "Investment Mobilized" was identified

Co-financing for the uP-Cycle project has been strategically selected to address specific knowledge needs identified during co-development of the components with all co-financiers, implementing partners and executing agents. The investments mobilised have been secured to support contributions to (1) global phosphorus emissions modelling and visualisation [PBL ? Global Analysis Nutrients Project] to support the implementation of scenarios and preparation of global maps of phosphorus emissions and waste flows for this project, as well as the implementation of future scenarios; (2) global public and private sector stakeholder engagement [UNEP WWQA ? Ecosystems WorkStream] and the development of the Global Sustainable Phosphorus Lakes Network drawing on global operations of the ecosystem restoration community of practice [Phoslock Ltd], (3) country-level activities on the development of phosphorus emission reduction programmes and stakeholder engagement [Chile National Government Multiple Departments; University of Edinburgh], and (4) large scale analyses of restoration effectiveness including engagement with industry and public bodies to develop policies supporting sustainable nutrient management (e.g., 17 case studies including the Danube Basin; EC MERLIN Project; UKCEH). We align a range of Mobilised Investments across National Governments, for example, delivering evidence and guidance on the development of Sustainable Phosphorus Strategies [e.g., Edinburgh Climate Change Institute & the Scottish Hydro Nations programme specialising in climate risk assessment and resilience], in the development of sustainable food systems, nutrient recycling programmes, and nature-based solutions [University of Link?ping; End of Waste Water, Urban Agriculture as Blue-Green Infrastructure; Spatial Recycling Scenarios; URBWAT; Garden Spillover], in data visualisation on phosphorus emissions, environmental and socio-economic impacts, and spatial planning to maximise gains [WRI; UKCEH; World Bank] and in identifying co-benefits of phosphorus management, for example through the UKCEH GCRF Nitrogen Hub, on improving nitrogen management in agriculture, saving money on fertilisers and making better use of nutrients in organic wastes [as well as activities led by the University of Edinburgh and University of Link?ping]. Finally, we build on partner activities for identifying interventions to increase uptake of circular economy approaches with respect to nutrient recycling, drawing on experiences of programme delivery globally [e.g., UK CEH GCRF Nitrogen Hub; University of Link?ping RECAP programme] and in data capture, management and interpretation [e.g., UKCEH UKSCAPE Programme, Towards Clean, Green Net Zero] and delivering on poverty alleviation [University of Edinburgh Nature?s Contribution to Poverty]. Such investments mobilized will contribute to the uP-Cycle Phosphorus project but will not be directly managed by the EA. Indeed as parallel investments they will be managed by the respective different budget holders to jointly achieve their goals more efficiently albeit in synergies. Finally, we have secured commitment and expressions of interest from Industry Partners including those operating in Ecosystem Restoration [Phoslock Ltd ? commitment received at PIF submission]. In addition, conversations during the PIF stage have also been initiated in wastewater management and nutrient recovery with Veolia, and in fertiliser production, supply and sustainable use with PhosAgro. The project team will continue engaging with the private sector throughout the PPG.

D. Indicative Trust Fund Resources Requested by Agency(ies), Country(ies), Focal Area and the Programming of Funds

Agency	Trust Fund	Country	Focal Area	Programming of Funds	Amount($)	Fee($)	Total($)
UNEP	GET	Global	International Waters	NA	2,000,000	190,000	2,190,000.00
				Total GEF Resources($)	**2,000,000.00**	**190,000.00**	**2,190,000.00**

E. Project Preparation Grant (PPG)

PPG Required **true**

PPG Amount ($)

50,000

PPG Agency Fee ($)

4,750

Agency	Trust Fund	Country	Focal Area	Programming of Funds	Amount($)	Fee($)	Total($)
UNEP	GET	Global	International Waters	NA	50,000	4,750	**54,750.00**
				Total Project Costs($)	**50,000.00**	**4,750.00**	**54,750.00**

Core Indicators

Indicator 4 Area of landscapes under improved practices (hectares; excluding protected areas)

Ha (Expected at PIF)	Ha (Expected at CEO Endorsement)	Ha (Achieved at MTR)	Ha (Achieved at TE)
280500.00	0.00	0.00	0.00

Indicator 4.1 Area of landscapes under improved management to benefit biodiversity (hectares, qualitative assessment, non-certified)

Ha (Expected at PIF)	Ha (Expected at CEO Endorsement)	Ha (Achieved at MTR)	Ha (Achieved at TE)
280,500.00			

Indicator 4.2 Area of landscapes that meets national or international third party certification that incorporates biodiversity considerations (hectares)

Ha (Expected at PIF)	Ha (Expected at CEO Endorsement)	Ha (Achieved at MTR)	Ha (Achieved at TE)

Type/Name of Third Party Certification

Indicator 4.3 Area of landscapes under sustainable land management in production systems

Ha (Expected at PIF)	Ha (Expected at CEO Endorsement)	Ha (Achieved at MTR)	Ha (Achieved at TE)

Indicator 4.4 Area of High Conservation Value Forest (HCVF) loss avoided

Ha (Expected at PIF)	Ha (Expected at CEO Endorsement)	Ha (Achieved at MTR)	Ha (Achieved at TE)

Documents (Please upload document(s) that justifies the HCVF)

Title	Submitted

Indicator 7 Number of shared water ecosystems (fresh or marine) under new or improved cooperative management

	Number (Expected at PIF)	Number (Expected at CEO Endorsement)	Number (Achieved at MTR)	Number (Achieved at TE)
Shared water Ecosystem	Global			
Count	**1**	**0**	**0**	**0**

Indicator 7.1 Level of Transboundary Diagonostic Analysis and Strategic Action Program (TDA/SAP) formulation and implementation (scale of 1 to 4; see Guidance)

Shared Water Ecosystem	Rating (Expected at PIF)	Rating (Expected at CEO Endorsement)	Rating (Achieved at MTR)	Rating (Achieved at TE)

Indicator 7.2 Level of Regional Legal Agreements and Regional management institution(s) (RMI) to support its implementation (scale of 1 to 4; see Guidance)

Shared Water Ecosystem	Rating (Expected at PIF)	Rating (Expected at CEO Endorsement)	Rating (Achieved at MTR)	Rating (Achieved at TE)

Indicator 7.3 Level of National/Local reforms and active participation of Inter-Ministeral Committees (IMC; scale 1 to 4; See Guidance)

Shared Water Ecosystem	Rating (Expected at PIF)	Rating (Expected at CEO Endorsement)	Rating (Achieved at MTR)	Rating (Achieved at TE)
Global Select SWE				

Indicator 7.4 Level of engagement in IWLEARN throgh participation and delivery of key products(scale 1 to 4; see Guidance)

Shared Water Ecosystem	Rating (Expected at PIF)	Rating (Expected at CEO Endorsement)	Rating (Achieved at MTR)	Rating (Achieved at TE)
Global Select SWE	1			

Indicator 11 Number of direct beneficiaries disaggregated by gender as co-benefit of GEF investment

	Number (Expected at PIF)	Number (Expected at CEO Endorsement)	Number (Achieved at MTR)	Number (Achieved at TE)
Female	33,239			
Male	33,399			
Total	66638	0	0	0

Provide additional explanation on targets, other methodologies used, and other focal area specifics (i.e., Aichi targets in BD) including justification where core indicator targets are not provided

Part II. Project Justification

1a. Project Description

1. <u>The global environmental and/or adaptation problems, root causes and barriers that need to be addressed (systems description)</u>

The pollution of fresh waters with phosphorus (and nitrogen), is one of the most conspicuous impacts of the Anthropocene.[1][1] During the 20th century, global phosphorus loading (and nitrogen loading) to freshwaters has doubled[2][2] mainly due to anthropogenic emissions from agriculture and wastewater (Figure 1). This is a consequence of national to global scale demands for food and non-food goods, some of which are destined for international trade.[3][3] These demands are embedded within national economic development plans which fly below the global sustainability policy radar. If phosphorus emissions are not reduced in the coming years, then the environmental and socio-economic impacts are predicted to be irreversible. [4][4]

Healthy waters underscore many of the UN Sustainable

Development Goals (SDGs). In its recent report on delivering SDG 6.3.2., UNEP (2021) states that ??quite likely for most countries, reducing nutrient release and transport will have the greatest positive impact on water quality.?[5][5] However, this assessment also indicates that monitoring and assessment of nutrient emissions to fresh waters is inadequate across many countries, at present.

Globally, biodiversity loss is occurring at a faster rate in freshwater ecosystems (83% decline between 1970 and 2014) than in any other environmental domain.[6][6] Phosphorus, together with other stressors, is a key driver of these losses.[7][7] Excess loading of nutrients to lakes causes harmful algal blooms (HABs) which serve as a stark indicator of ecosystem collapse. Such conditions threaten human health and drinking water supplies, drive biodiversity loss, including fish kills, and bleed these effects towards the coastal ecosystems into which they drain.[8][8] These effects will be exacerbated in many cases by climate change. However, phosphorus enriched lakes are also an important source of greenhouse gas emissions, the net present value global social costs of which could increase from US$7.5 to $81 trillion (2015 ? 2050) following the current phosphorus emissions trajectory [9][9].

To save space references are listed fully only once. If the reference appears again later in the document the surname of the first author and document title will appear only.

[1]Bojana Baj?elj et al., ?Importance of Food-Demand Management for Climate Mitigation,? *Nature Climate Change* 4, no. 10 (October 31, 2014): 924?29, https://doi.org/10.1038/nclimate2353; C J V?r?smarty et al., ?Global Threats to Human Water Security and River Biodiversity.,? *Nature* 467, no. 7315 (September 30, 2010): 555?61, https://doi.org/10.1038/nature09440.

[2] Arthur H. W. Beusen et al., ?Global Riverine N and P Transport to Ocean Increased during the 20th Century despite Increased Retention along the Aquatic Continuum,? *Biogeosciences* 13, no. 8 (April 27, 2016): 2441?51, https://doi.org/10.5194/bg-13-2441-2016.

[3] Helen A. Hamilton et al., ?Trade and the Role of Non-Food Commodities for Global Eutrophication,? *Nature Sustainability* 1, no. 6 (June 14, 2018): 314?21, https://doi.org/10.1038/s41893-018-0079-z.

[4] Stephen R Carpenter and Elena M Bennett, ?Reconsideration of the Planetary Boundary for Phosphorus,? *Environ. Res. Lett* 6 (2011): 14009?21, https://doi.org/10.1088/1748-9326/6/1/014009; W. Steffen et al., ?Planetary Boundaries: Guiding Human Development on a Changing Planet,? *Science* 347, no. 1259855 (February 13, 2015), https://doi.org/10.1126/science.1259855.

[5] UNEP, *Progress on Ambient Water Quality. Tracking SDG 6 Series: Global Indicator 6.3.2 Updates and Acceleration Needs.* (Nairobi: United Nations Environment Programme, 2021).

[6] A.J. Reid et al., ?Emerging Threats and Persistent Conservation Challenges for Freshwater Biodiversity,? *Biological Reviews* 94, no. 3 (June 22, 2019): 849?73, https://doi.org/10.1111/brv.12480; D. Tickner et al., ?Bending the Curve of Global Freshwater Biodiversity Loss: An Emergency Recovery Plan,? *BioScience* 70, no. 4 (April 1, 2020): 330?42, https://doi.org/10.1093/biosci/biaa002; WWF, *Living Planet Report - 2018: Aiming Higher*, ed. M. Grooten and R.E.A Almond (Switzerland, Gland, 2018).

[7] S. Birk et al., ?Impacts of Multiple Stressors on Freshwater Biota across Spatial Scales and Ecosystems,? *Nature Ecology & Evolution*, June 15, 2020, 1?8, https://doi.org/10.1038/s41559-020-1216-4; Tickner et al., ?Bending the Curve of Global Freshwater Biodiversity Loss: An Emergency

Recovery Plan.?

[8] N.N. Rabalais et al., ?Global Change and Eutrophication of Coastal Waters,? *ICES Journal of Marine Science* 66, no. 7 (August 1, 2009): 1528?37, https://doi.org/10.1093/icesjms/fsp047; Val H. Smith and David W. Schindler, ?Eutrophication Science: Where Do We Go from Here?,? *Trends in Ecology & Evolution* 24, no. 4 (April 2009): 201?7, https://doi.org/10.1016/j.tree.2008.11.009.

[9] J.A. Downing et al., ?Protecting Local Water Quality Has Global Benefits,? *Nature Communications 2021 12:1* 12, no. 1 (May 11, 2021): 1?6, https://doi.org/10.1038/s41467-021-22836-3.

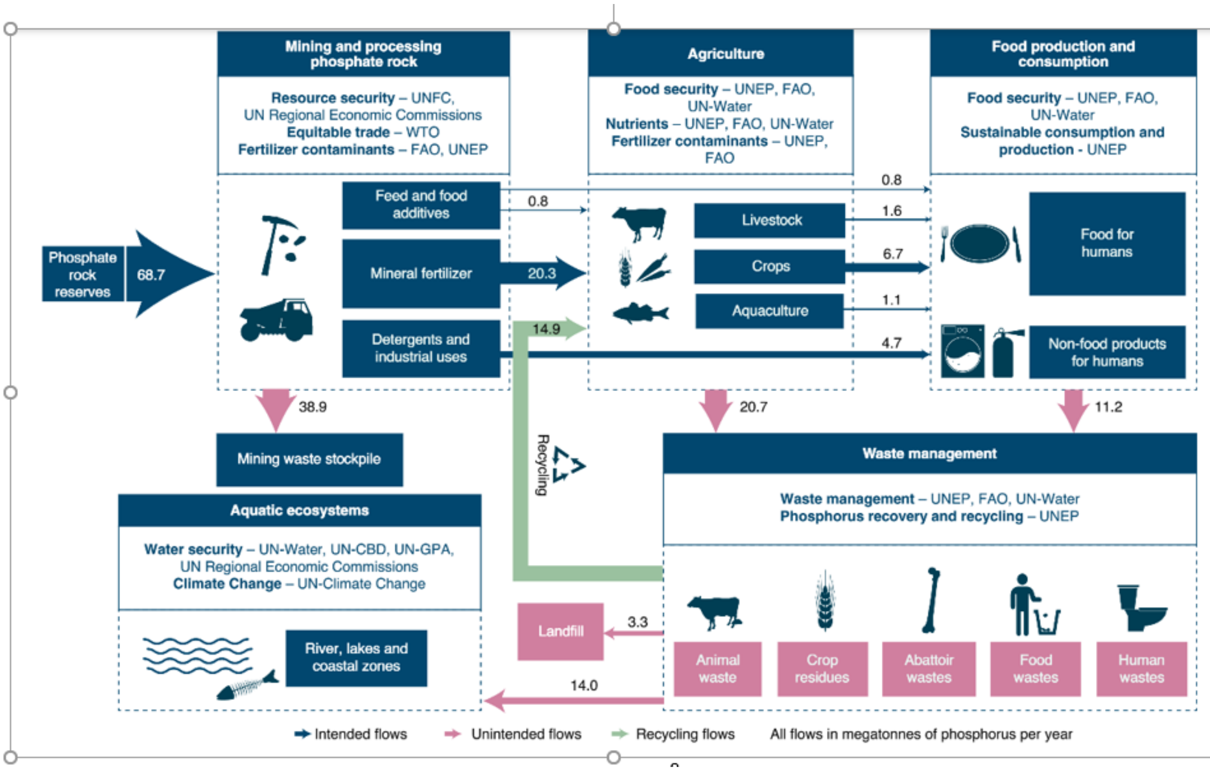

Figure 1. The global phosphorus system. Global phosphorus flows[8] and fragmentation of existing international frameworks are shown. There is currently no intergovernmental coordination mechanism on phosphorus, which is needed to link phosphorus science-policy support between existing intergovernmental frameworks and other initiatives. Key bodies with relevant interests include the UN Environment Programme (UNEP) and Food and Agriculture Organization (FAO), UN-Water, the UN Regional Economic Commissions, the UN Framework Classification for Resources (UNFC), the World Trade Organization (WTO), the UN Convention on Biological Diversity (CBD), the UN the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (UN-

GPA) and the UN Climate Change Convention (UN Climate Change). Arrow widths are proportional to the magnitude of phosphorus flows in 2013; units shown are in megatonnes of phosphorus per year.

Rivers and lakes combine to form complex drainage basins through which global nutrient exports have increased by 31% for phosphorus and 60% for nitrogen between 1970 and 2020 (currently, 49 Mt yr^{-1} of nitrogen and 5 Mt yr^{-1} of phosphorus;[1]). The delivery of phosphorus and nitrogen, in particular, from land to sea has been related to increasing coastal eutrophication. The Global Environment Facility Transboundary Waters Assessment Programme (GEF TWAP) reported that, if current nutrient loading trends continue, a further 13 large marine ecosystems will be at increased risk of eutrophication by 2050 relative to 2000 (IOC-UNESCO and UNEP, 2016). It also highlighted challenges in predicting future trends of degradation in transboundary lakes and reservoirs as a result of limited data, environmental and ecological quality standards, mechanistic understanding of large ecosystem responses to environmental change, uncertainties in projected stressors, and a lack of transparency on governance issues (ILEC and UNEP, 2016). Action is required to address these issues, for example, through the development and implementation of SDG 6.3.2 indicators to support national to global nutrient emission reductions.[2] In doing so, there is an opportunity to target benefits for both freshwater and coastal ecosystems where emissions reductions programmes are considered at scale.

The global outlook for phosphorus loading to fresh waters is bleak. Phosphorus demand in the agricultural sector is predicted to double, again, by 2050, further increasing emissions to freshwater and coastal ecosystems.[3] Phosphorus losses from food production for domestic consumption will impact directly on catchments that have been ?set-aside? for agriculture (e.g., >70% of the anthropogenic phosphorus load in the Yangtze River basin is from agriculture). Losses of phosphorus from wastewater to fresh water are expected to increase globally by up to 70% by 2050 (equivalent to 2.4 Mt phosphorus per year[4]). Phosphorus pollution from wastewater will impact those catchments connected to urban populations and rural settlements with poor sewerage connections (e.g., a concern in the Lake Villarrica basin, Chile). As marine fisheries fail, emissions from freshwater aquaculture (global turnover of US$ 160.2 billion yr^{-1}) are projected to rise from 0.94 Mt phosphorus yr^{-1}, estimated in 2016.[5]

As nitrogen use is being transformed towards a more sustainable future,[6] phosphorus remains underrepresented across many national policies. No global policy exists for phosphorus. Business as usual for phosphorus ignores the impacts of degraded natural capital on the growth of the green economy.[7] It assumes that restoration will be affordable, whereas investments in nature-based solutions must increase fourfold by 2050 (from US$ 133 billion in 2020) to meet global ambitions.[8] It neglects the value of circularity in the anthropogenic phosphorus cycle, where currently less than 50% of phosphorus wastes are recycled back to the global food system.[9] Finally, it fails to recognize that unsustainable phosphorus use is driven, in part, by the international trade of food and non-food goods, creating a novel transboundary context to nutrient impacts across freshwater and coastal ecosystems.

There is a pressing need to widen the scope and accelerate the development of phosphorus emissions reduction programmes, within a new narrative set by the global restoration practitioner community. There is international recognition of the need for an Emergency Recovery Plan for freshwater ecosystems[10][10] and international coordination of action to deliver improved global phosphorus sustainability is key to this goal.[11][11] In addition, there is international recognition of the need to consider a coordinated approach to reduce the impact of land-based activities on coastal-marine ecosystems.[12][12] A globally coherent Framework is required to address these goals which reflects geographical contexts. In some countries phosphorus emissions reduction is already a component within water quality management programmes (e.g., USA, Canada, Australia, Europe, UK, and China), and here emissions are decreasing, or are expected to decrease. In most developing economies, however, phosphorus emissions reduction programmes are in their infancy or do not yet exist. Here, emissions are increasing, for example in Latin America and Asia.

The development of the UN SDG Indicators, and in particular SDG 6.3.2, has highlighted a significant evidence gap in terms of nutrient emission and impacts reporting in low GDP countries.[13][13] Here, the SDG Global Accelerator Framework encompasses Data & Information, Financing, Capacity Development, Innovation, and Governance to address this issue and to help countries to work towards the development of mitigation responses to improve water quality. However, where baseline monitoring data are limited, global modelling outputs and remote sensing can be used to gap-fill offering analyses of trends in phosphorus and nitrogen emissions (i.e., global nutrient emissions models), and algal blooms (remote sensing) as well as the development of future scenarios to inform preliminary mitigation and policy development.[14][14]

A framework for sustainable phosphorus management (as outlined in Focus Box 1) would support globally coherent ambitions and actions targeted at areas of concern with respect to freshwater and coastal degradation. Such a framework should empower countries to reach beyond traditional emissions reduction programmes to unlock multiple benefits, for example, aligned through the SDGs (e.g., on equality, food security, terrestrial biodiversity etc.), and, translated into national and transboundary policies through use-based targets. Many examples of such innovations have been implemented at the lake basin scale through eutrophication management programmes across the world, representing an International Community of Practice. Recent examples at the large lake basin scale (e.g., Lake Toba, Indonesia[15][15]) have demonstrated that phosphorus emissions reductions across sectors can increase the resilience of freshwater biodiversity, water, and food systems, whilst also releasing new sustainable development opportunities (e.g., through eco-tourism).

The immediate opportunity now lies in mobilizing the international community of practice through the co-development of an International Framework for Sustainable Phosphorus Management, to include a monitoring and assessment system designed to optimize existing and emerging emissions reduction programmes. On-the-ground support should be prioritized towards countries where freshwater ecosystems are under severe or growing stress from phosphorus emissions, where large scale emissions reductions may benefit sensitive transboundary (lake or marine) ecosystems, and where government and public readiness for change are high. We focus here on Chile (see Baseline), where phosphorus emissions to the Chilean Lake District and other regions has been increasing, where land-based activities have a significant impact on nutrient delivery to the Humboldt Current Large Marine Ecosystem, and where the Chilean Ministry of the Environment are in Stage 1 (Focus Box 1) of implementing phosphorus emissions reduction programmes. In this case, and others, there is an urgent need to demonstrate the benefits of emissions reductions across sectors and scales supported by a new narrative on global sustainable phosphorus use integrated across the existing global policy arena.

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[1] World Water Quality Alliance, *World Water Quality Assessment: First Global Display of a Water Quality Baseline. A Consortium Effort by the World Water Quality Alliance - towards a Full Global Assessment.* (Nairobi: . Information Document Annex for display at the 5th Session of the United Nations Environment Assembly, 2021).

[2] UNEP, *Progress on Ambient Water Quality. Tracking SDG 6 Series: Global Indicator 6.3.2 Updates and Acceleration Needs.*

[3] J.M. Mogoll?n et al., ?More Efficient Phosphorus Use Can Avoid Cropland Expansion,? *Nature Food* 2, no. 7 (July 1, 2021): 509?18, https://doi.org/10.1038/s43016-021-00303-y.

[4] P.J.T.M. van Puijenbroek, A.H.W. Beusen, and A.F. Bouwman, ?Global Nitrogen and Phosphorus in Urban Waste Water Based on the Shared Socio-Economic Pathways,? *Journal of Environmental Management* 231 (February 1, 2019): 446?56, https://doi.org/10.1016/j.jenvman.2018.10.048.

[5] Y. Huang et al., ?The Shift of Phosphorus Transfers in Global Fisheries and Aquaculture,? *Nature Communications* 11, no. 1 (December 17, 2020): 355, https://doi.org/10.1038/s41467-019-14242-7.

[6] M.A. Sutton et al., ?The Nitrogen Decade: Mobilizing Global Action on Nitrogen to 2030 and Beyond,? *One Earth* 4, no. 1 (2021): 10?14, https://doi.org/10.1016/j.oneear.2020.12.016.

[7] P Dasgupta, The Economics of Biodiversity: The Dasgupta Review (London: HM Treasury, 2021).

[8] Dasgupta. ?The Economics of Biodiversity: The Dasgupta Review?

[9] W.J. Brownlie et al., ?Global Actions for a Sustainable Phosphorus Future,? *Nature Food* 2 (2021): 71?74.

[10] Tickner et al., ?Bending the Curve of Global Freshwater Biodiversity Loss: An Emergency Recovery Plan.?

[11] Brownlie et al., ?Global Actions for a Sustainable Phosphorus Future.?

[12] IRP, *Building Biodiversity - The Natural Resource Management Approach - A Think Piece of the International Resource Panel Co-Chairs.*, ed. I. Poto?nik, J., Teixeira, 2021, https://wedocs.unep.org/bitstream/handle/20.500.11822/35972/BDNR.pdf.

[13] UNEP, *Progress on Ambient Water Quality. Tracking SDG 6 Series: Global Indicator 6.3.2 Updates and Acceleration Needs.*

[14] World Water Quality Alliance, *World Water Quality Assessment: First Global Display of a Water Quality Baseline. A Consortium Effort by the World Water Quality Alliance - towards a Full Global Assessment.*

[15] World Bank Group, *Improving the Water Quality of Lake Toba, Indonesia.* (Washington, DC.: World Bank, 2018), https://openknowledge.worldbank.org/handle/10986/32196.

Focus Box. A Primer for the *Net Zero P for Lakes* Framework. The Net Zero P concept is designed to aid policy makers and practitioners in the development of leadership pathways to deliver emissions reductions that enhance the natural environment whilst enabling sustainable and inclusive economic growth. Here we split this pathway into two interrelated steps, recognising that emissions reductions must be phased through:

(1) halting increasing present-day emissions trajectories to avoid further ecosystem degradation and then reducing levels of future emissions to deliver ecosystem recovery (Step 1: *Towards Net Zero P*), and

(2) accelerating the selection, placement and implementation of programmes of measures that deliver multiple benefits along the full value chain, in the long term (Step 2: *Beyond Net Zero P (or Net Zero **P**lus))*.

The general architectures of these phases are outlined below. Whereas Step 1 should be the foundation of emissions reductions investments in all cases leading ultimately to ecosystem restoration, we envisage that the additional gains delivered through Step 2 will be basin and country-specific, and dependent on relevant policy frameworks (example co-benefits have been included). Finally, the approach recognises that each ecosystem has a specific carrying capacity for phosphorus emissions and that emissions reductions must be planned within this context.

Step 1. Towards Net Zero P for ecosystem recovery. Addresses the urgent need to identify and control major anthropogenic emissions sources to halt further ecosystem degradation and then to implement measures to reduce emissions in the medium to long-term that will support sustained ecosystem recovery.

Transforming phosphorus emissions assessments

Source Identification, Monitoring and Assessment utilising integrated sensor networks, earth observation, regulatory monitoring data (e.g., discharge consents), and catchment land-use export modelling to quantify sector-specific contributions to the anthropogenic emissions landscape.

Setting Ecological and Natural Capital Targets linking anthropogenic source-specific emissions reduction contributions to ecosystem responses using empirical data and ecosystem modelling tools and defining the carrying capacity of the systems.

Emissions reductions at scale to enhance the natural environment

Emissions Reduction at Source, identifying and accelerating sector-specific opportunities to reduce direct emissions to existing waste streams and/or to optimise practices to increase phosphorus use efficiency to reduce point and diffuse source emissions.

Phosphorus Capture and Re-Use, assessing capacity for Nature-Based Solutions, both in urban and rural settings, to divert, capture and recover phosphorus from points of accumulation in the natural environment, upstream of sensitive ecosystems.

Implement Lake Ecosystem Resilience Enhancing Measures, ensuring that ecological recovery following emissions reductions is effective, including the creation of refuge habitats for threatened species, the control of legacy phosphorus pollution in lake bed sediments, and the control of other important stressors (e.g., climate change, non-native invasive species, other nutrients and pollutants) which may constrain ecosystem recovery in the long term.

Step 2. Beyond Net Zero P (or Net Zero P Plus). Ensures that emissions reduction measures are selected that deliver wider gains, including supporting sustainable and inclusive economic growth, enhancing biodiversity in connected ecosystems across scales, and improving human interactions with the natural environment through education and knowledge exchange.

Enabling sustainable and inclusive economic growth

Embracing the Circular Economy to identify opportunities that address losses of phosphorus and other nutrients along the full value chain delivering on wider sustainability ambitions including the reduction of food waste and wastewater discharges.

Increasing Resilience in Food and Drinking Water Sectors by reducing reliance on mined (and imported) inorganic phosphorus fertilisers in agriculture and aquaculture (and other end-uses), within the carrying capacity of the system, whilst reducing drinking water treatment costs associated with the reduction of harmful algal blooms and their toxins.

Supporting Growth in Eco-Tourism, Business and the Housing Sectors by enhancing the value of natural capital to contribute to the creation of vibrant and dynamic water economies working with stakeholders to develop opportunities for businesses or industries for whom clean, safe and biodiverse lakes are a critical resource. Linking P-Smart housing development schemes to maximise recycling, minimise emissions from domestic sources whilst informing placement of developments outside phosphorus critical zones.

Contributing to Net Zero Carbon Ambitions by reducing direct greenhouse gas emissions from standing waters related to a reduction in phosphorus driven algal biomass and through the selection of Nature-Based Solutions that deliver both reductions in phosphorus emissions from land to water as well as greenhouse gas emissions from land to atmosphere.

Empowering communities

Fostering Inclusive Sustainability Communities to ensure that all members of society play an active role in the development of future emissions reduction plans, including, Youth and Indigenous Peoples Assemblies.

Accelerating Inclusive Sustainable Innovation working across sectors to support the development of innovations, jobs and opportunities through the transition to new emissions reduction practices (e.g., small holding farmers) for vulnerable groups who are historically socially and/or economically reliant on the *status quo*.

Enhancing Capacity across the Institutional Framework by connecting knowledge providers (e.g., universities, citizens? science practitioners, businesses, and regulatory bodies) through shared education and skills development activities to underpin the long-term knowledge base.

To achieve this, we must first overcome the following **tractable barriers** to change:

1. Lack of an internationally relevant phosphorus monitoring and assessment system

Baseline data for indicators of phosphorus sustainability, including emissions to waterbodies and ecological and socio-economic impacts, are essential for underpinning restoration or protection targets at catchment to national scales. However, there is, currently, no internationally accepted list of indicators or assessment system. Monitoring and assessment programmes provide a critical link between information, evidence-based decision making and policy development and should be used to inform a common approach to adaptive management planning, including those relevant to transboundary ecosystems. This is especially important given ecosystem restoration is often based on long-term targets, that the impacts on waterbodies of multiple pressures, such as climate change, population growth and urbanization, are rarely considered in target setting[1], and where emissions reductions require coordinated action across countries. For phosphorus, the lack of such a system limits the ambition of restoration investments, which currently focus on biodiversity gains, but ignore other benefits as described within the UN SDGs. IN addition, where targets exist, they commonly include only pressure-related targets and lack clarity on used-based targets. An internationally developed monitoring and assessment system considering phosphorus as a driver of socio-economic and ecological systems across scales is urgently needed, especially in countries where phosphorus emissions are increasing rapidly. General frameworks exist to support the development of Integrated Catchment Management Programmes across scales. For example, UNEP?s Framework for Freshwater Ecosystem Management[2], the International Lake Environment Committee (ILEC) Integrated Lake Basin Management models, and the SDG 6 SDG Global Accelerator Framework which are adaptable for phosphorus and acknowledge the need for accurate evidence to inform decisions within coordinated governance, policy, and institutional frameworks. The potential to implement phosphorus emission reduction programmes at scale to relieve stress on transboundary ecosystems should be reflected within a new Global Sustainable Phosphorus Framework.

2. Poor knowledge exchange limits the effectiveness of phosphorus emissions reduction programmes

There is a pressing need to enhance knowledge exchange on the challenges, solutions and multiple benefits of phosphorus emissions reductions to accelerate large scale initiatives. Many, currently disparate, case studies exist with which to exemplify the complexity of including phosphorus within integrated catchment management programmes across large ecosystems, including transboundary rivers, lakes and LMEs. These case studies represent a global evidence base on the implementation of improved sustainable phosphorus management practices across the value chain, within an Ecosystem Based Management Approach. The drive for restoration through phosphorus emissions reductions to address the decline of biodiversity in lakes across, for example, Europe, North America, and New Zealand has led to the development of an impressive evidence base on sustainable nutrient management. For example, nutrient source apportionment and ecosystem response monitoring approaches have been developed through the EU Water Framework Directive and USA Clean Water Act. Ecosystem modelling tools are available to predict ecological resilience and recovery. Ecosystem service models have been developed and applied to map out, in time and space, the benefits of reduced phosphorus emissions on lakes and their catchments, supporting policy development. These models can be used collectively to deliver *future world* scenarios, for example, including the effects of climate change or urban development. Nature-based solutions have been developed to support increased efficiency in agriculture and wastewater discharges, including reducing losses through recapture and re-use of nutrients underpinning novel landscape planning strategies to support this. Actions to reduce losses from agriculture can be framed within the wide-reaching 5R approach[3] (i.e., Re-align phosphorus inputs, Reduce losses to water, Recycle, Recover from wastes, and Redefine food systems) offering basin to global scale application.[4] The use of so-called in-lake ?geoengineering? and/or ?biomanipulation? techniques offer immediate, but shorter-term, relief from the effects of HABs when phosphorus pollution reduction from land-based sources will be slow. Such innovations can remain out-of-reach for many developing countries. Innovative knowledge exchange platforms have been established in some countries and regions, for example, the European Sustainable Phosphorus Platform (see Baseline scenario for other examples), which offer access to evidence on emerging measures, but not necessarily the expertise to select, monitor and apply them. Knowledge across these multiple disciplines remains siloed, both geographically, and within sectors limiting their uptake in countries where emissions reductions programmes are emerging.

3. Low awareness of the public and private sectors on the rewards of improving phosphorus sustainability, and the risks of inaction.

At the global scale, food demand is currently the engine driving the phosphorus cycle. However, despite the importance of phosphorus for food, drinking water and environmental health, public awareness of the impacts of food choice on phosphorus sustainability remains low.[5] Whilst there is a pressing need for education on the impacts of consumer behaviour (i.e., *purchasing power),* businesses and governments will ultimately drive change. The currency of that change will be natural capital. However, many companies remain blind to their exposure to Nature Related Financial Risks, including those associated with phosphorus pollution [6]. These risks may, for example, include losses to real estate value and income through eco-tourism, increases in litigation costs associated with pollution discharges and water treatment, and production capacity decreases linked to natural disasters (e.g., fish kills in lakes for aquaculture). The accounting methods to make such assessments are available but not yet widely applied. In the USA, estimates of such losses in response to eutrophication are *ca.* US$ 2.2 billion per year. In the UK, similar assessments indicate losses will increase from *ca.* US$ 245 million in 2018 to *ca.* US$ 595 million by 2080 as a result of climate warming, alone. These losses will increase with phosphorus pollution. There is a clear need to develop assessment and reporting systems for phosphorus that supports both private companies and public bodies in assessing their financial exposure over the short to long terms and their performance in relation to pollution monitoring and reduction, within an internationally relevant framework. The opportunity exists for businesses to foster growing consumer demand for products with lower pollution footprints and to expand into new market areas that deliver nutrient pollution reductions and promise lower exposure to nature-related financial risks[7]. The potential for investments in nature-based solutions to offset emissions elsewhere is gathering attention but importantly, the net effects of emissions reductions must deliver benefits to natural capital, so unlocking the wider values of ecosystem restoration.

4. Where they exist, basin to national scale phosphorus emissions reduction policies are fragmented and limited in ambition

Strategies to improve phosphorus management for fresh waters, or for phosphorus sustainability generally, are conspicuously absent in many regions and are disconnected globally.[8] Few policies relating specifically to sustainable phosphorus management exist at the national scale and none at the global scale.[9] The interactions between countries and regions that drive the export and import of phosphorus, and also phosphorus emission from catchment to national and transboundary scales, seem untouchable to most lake basin managers. Phosphorus was identified as an emerging issue in the UNEP Year Book 2011.[10] However, relevant international sustainability initiatives do not specifically mention phosphorus, including the SDGs,[11] and the Aichi Biodiversity Targets.[12] This is despite the considerable contribution that improving phosphorus sustainability can make to achieving the goals for freshwater biodiversity and wider benefits.[13] There is a need for more international consistency in the approach to phosphorus management in lake catchments, focusing on the release of multiple societal benefits, as well as better integration across water policy and other policy domains including agriculture, urban planning, flooding, and climate change and energy.[14] To address this, it is important to demonstrate the value of such a scalable approach in a country with an increasing phosphorus pollution problem and where ecosystems are of high socio-economic value.

Addressing the Barriers ? Project architecture

This project has been co-developed with key actors to address the barriers outlined above (specifically addressed through Component Overview, Section 3). We focus here on lakes as the primary loci for ecosystem degradation related to phosphorus emissions from the landscape. In doing so, we recognise that coordinated initiatives to reduce emissions for ecosystem protection can deliver benefits that resonate along the full value chain, and from emissions sources through connected freshwater and coastal receptor ecosystems. It recognises the need for international coordination and direction in this area to support the reduction of impacts from land-based activities on transboundary ecosystems (e.g., Transboundary Lakes and Large Marine Ecosystems) as well as global ambitions, for example, in relation to SDG 6.3.2. To support these needs, sustainable phosphorus management must be better integrated across basin, national, and international policy arenas and our project components are structured around these scales. We will adopt a multidisciplinary, international approach, bringing together and informing industry, policy makers, and the ecosystem restoration community of practice, alongside academic and non-governmental bodies with expertise in implementing large scale phosphorus emissions reduction programmes, or who are tasked with developing them. We will focus this community on the development of an internationally coordinated monitoring and assessment approach designed to optimize the benefits of existing and emerging phosphorus emissions reduction programmes and to produce comparable and scalable data resources to support decision making, framed within a novel Net Zero Phosphorus concept (Focus Box 1). This approach will be piloted in collaboration with the Ministry for the Environment, Chile and their evidence providers, where phosphorus pollution in the Chilean Lake District is increasing and where land-based pressures are a key concern of the Humboldt Current Large Marine Ecosystem Strategic Action Program. As such, the architecture of the project allows consideration of challenges and solutions across scales. It allows consideration of a basin to transboundary approach to sustainable phosphorus management and will address the critical need to accelerate the uptake of advanced surveillance systems in emerging economies, demonstrating this approach through on-the-ground activities in Chile to inform similar activities in other world regions. Finally, it will set a new narrative on sustainable phosphorus management through engagement with established global bodies and programmes (as outlined in the Baseline section below).

2. The baseline scenario and any associated baseline projects

We outline below the current baseline conditions across catchment to global scales as well as relevant programmes/projects that have delivered important evidence to support the uP-Cycle Project. We also highlight those activities and investments that stand to benefit directly from the project deliverables and outcomes.

The Global baseline

In 2013, the opportunity was highlighted for a 20% improvement in nutrient use efficiency by 2020 across the full chain of food and waste systems.[15] Since this time, several nutrient sustainability goals have been proposed. The United Nations Environment Programme (UNEP) Colombo Declaration calls for the halving of nitrogen (N) waste by 2030.[16][16] The working group of the Post-2020 Global Biodiversity Framework proposed to reduce pollution from excess nutrients by 50% by 2030.[17][17] The Farm to Fork strategy underpinning the European Green Deal, for example, calls for actions to reduce nutrient losses by at least 50% and to reduce fertiliser use by at least 20% by 2030.[18][18] Despite this, phosphorus management remains largely ignored in the food and environmental policy agendas of most countries, and international conventions.[19][19] Progress remains hindered by a lack of policy and public awareness, fragmentation of actions and policies, and the absence of intergovernmental coordination.[20][20] The momentum for action on nitrogen pollution is building; the first United Nations Environment Assembly (UNEA) resolution for sustainable nitrogen was agreed in 2019.[21][21] A lack of comparable action for phosphorus has provoked scientists worldwide to sign ?**the Call for International Action on Phosphorus?** (www.opfglobal.com); a petition initiated by the UKCEH and the European Sustainable Phosphorus Platform that calls for government support in addressing the phosphorus emergency by coordinating action across sectors and nations. By the end of 2020, over 500 scientists had signed this Call. The uP-Cycle project will deliver a new narrative on Global Sustainable Phosphorus Management through activities focused on the international policy arena in Components 1 and 4.

Global Baseline - relevant GEF supported projects

The towards an ?International Nitrogen Management System? project (GEF project ID: 5400; Implemented by UNEP and executed by CEH, 2017-2022)

The GEF/UNEP-UKCEH ?Towards the International Nitrogen Management System? project (INMS) is developing the evidence base to showcase the need for effective practices for global nitrogen management and to highlight options to maximize the multiple benefits of better nitrogen use. uP-Cycle will build on the successes of INMS, outlined below, supporting activities within the global nitrogen sustainability policy arena to build on the obvious synergies between phosphorus and nitrogen. In addition, we will have access to evidence and tools with which to enhance our proposed Innovations Hub, including a measures database for sustainable nitrogen management which may also deliver on phosphorus sustainability. INMS offers access to over 70 global project partners, supporting the work through co-finance which includes the establishment of five funded regional demonstrations in Africa, South Asia, East Asia, Latin America, and Eastern Europe with a self-funded demonstration in Western Europe and the US. Since the launch of the INMS, global progress on nitrogen has rapidly accelerated. Learning from the UNECE, a partnership was formed in 2017 between INMS and the South Asian Cooperative Environment Programme (SACEP) to draft a first-ever UN Resolution on Sustainable Nitrogen Management, adopted by the Fourth UN Environment Assembly in March 2019 (UNEP/ EA.4/Res.14). Among its provisions, the nitrogen resolution calls for the UNEP executive director to ??consider the options for facilitating improved coordination of policies across the global nitrogen cycle at the national, regional and global levels, including consideration of the case for establishing an intergovernmental mechanism for coordination of nitrogen policies?. In response to this, the INMS has led the development of an inter-convention nitrogen coordination mechanism (INCOM). INMS is now following up with member states under a newly formed UNEP Nitrogen Working Group, preparing the basis for establishing INCOM. Under this approach, INMS provides nitrogen science support relevant across multiple multi-lateral environmental agreements. This process was accelerated with the launch of the UN Global Campaign on Sustainable Nitrogen Management in Colombo, Sri Lanka, in October 2019. The resulting Colombo Declaration agreed on the ambition to halve nitrogen waste by 2030 as part of National Nitrogen Action Plans while endorsing the UNEP Road Map for Sustainable Nitrogen Management. The INMS project is implemented by the UN Environment Programme (UNEP) with 6M USD funding through the Global Environment Facility

(GEF) (GEF project ID: 5400). INMS is executed through the UKCEH, on behalf of the International Nitrogen Initiative (INI).

The INMS project has greatly raised awareness of policymakers and stakeholders on the importance of nutrient management, with a focus on nitrogen. The uP-Cycle project will build upon this progress by providing a focus on phosphorus, providing balanced improvement in nutrient management across a well-established global community.

Global foundations for reducing nutrient enrichment and oxygen depletion from land-based pollution, in support of Global Nutrient Cycle (GEF 4212; 2011-2015; implemented by UNEP and executed by The Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA)).

The project, which was global in scope, contributed to building the knowledge foundations on nitrogen and phosphorus nutrient cycling, the impacts on the environment and the development of a Global Nutrient Management Decision-Support Toolbox. The toolbox is a web-based information portal to support nutrient management, focused predominantly on nitrogen, including more than 200 nutrient management practices and policies in use around the world and case study accounts on implementation of best management practices and tools with which to assess nutrient loading scenarios at a river basin scale.

The uP-Cycle project will develop on the progress made in the project through its ?Innovation Hub?. The ?Innovation Hub? will not replicate work already done but provide a more detailed source of information on phosphorus management practices.

Towards a Lake Basin Management Initiative and a Contribution to the Third World Water Forum: Sharing Experiences and Early Lessons in GEF and non-GEF Lake Basin Management Projects (GEF project code: 1665; 2002 ? 2006; implemented by World Bank Group).

This project catalysed communication in lake restoration practitioners and used this knowledge to produce training materials that can be used generally as an introduction to Integrated Lake Basin Management. These outputs informed the UNEP Framework for Freshwater Ecosystem Management. The uP-Cycle project will build on this network to inform the development of the Zero P Lakes Network and will learn from the capacity development materials produced to support the production of targeted guidance on sustainable phosphorus management leading to lake ecosystem recovery.

GEF Transboundary Waters Assessment Programme (TWAP; GEF Project code: 4489; 2012 ? 2017; implemented by UNEP).

The Transboundary Waters Assessment Programme (TWAP) aimed to provide a baseline assessment across the world?s transboundary water systems (groundwater, lakes/reservoirs, rivers, large marine ecosystems) capturing the impacts of human activities and natural processes, and the consequences of these on human populations. The methodologies for conducting a global assessment of these water systems were developed during the TWAP Medium-sized Project (2009-2010). The TWAP Full-sized Project implemented the first global comparative assessment for transboundary waters to support GEF and other international organizations in setting priorities for supporting the conservation of transboundary water systems. The TWAP assessment is the first global assessment that uses quantified indicators of system states, pressures and impacts under three broad themes: biophysical, socioeconomic, and governance. TWAP has demonstrated the widespread incidence of the risk of unsustainability in transboundary aquifers, lakes, rivers, Large Marine Ecosystems and the open ocean, across the planet. To reduce and reverse the causes of risk to meet Sustainable Development Targets by or before 2030, TWAP stresses the need for countries to develop further their specific monitoring of key indicators to identify and mitigate anthropogenic and natural processes impacting their transboundary ecosystems. The uP-Cycle project will respond directly to this need through the on-the-ground activities focused on emissions reductions programmes, potentially delivering benefits to LMEs, for example, the Humboldt Current LME which receives inputs from land-based activities in Chile (Component 3), and through engagement and knowledge exchange with representatives of nutrient management programmes focused on Transboundary Lakes (e.g., Lake Victoria, Lake Erie and others, to be included in the Community of Practice; Component 2).

GEF Strategic Partnership on the Black Sea and Danube River Basin including (a) The Danube Regional Project (DRB to 2007): Strengthening the Implementation Capacities for Nutrient Reduction and Transboundary Cooperation in the Danube River Basin; (b) The Black Sea Ecosystems Recovery Project (BSERP): Control of eutrophication, hazardous substances and related measures for rehabilitating the Black Sea ecosystem; and (c) World Bank Investment Fund for Nutrient Reduction in the Black Sea/Danube Basin, and GEF Funded Danube River Basin Environmental Management Project (GEF ID: 399).

The GEF Strategic Partnership on the Black Sea and Danube Basin supported 17 countries in addressing pollution in the Danube and its impact on the Black Sea LME. This GEF support, along with support from the UNDP and the World Bank, was one founding stone of the Danube Commission, and informed the development of the European Water Framework Directive, the main mechanisms under which the Danube basin is now managed. We will learn lessons from such investments, including industry collaborations that lead to efficient nutrient reductions from key industry hotspots via targeted policy reforms. While specific geographical drivers of change may have advanced progress (EU accession prospects etc.) these past lessons may give an indication both of the necessity, drivers and means by which to advance industry dialogue at the level of this MSP. We will access contemporary information on nutrient management experiences in the Danube through the EC MERLIN Project, listed within the UK CEH Co-Financing (Table C and associated text).

Global - relevant non-GEF Projects/Initiatives

The Our Phosphorus Future project (2017-2022)

The ?Our Phosphorus Future? project (OPF) responds to the critical need to provide direction from the scientific community to progress issues on sustainable phosphorus use, including water quality degradation and biodiversity loss. The OPF project brings together over 200 scientists and industry experts from around the world to develop the OPF report. The report identifies the priority issues, possible solutions and the capacity to address phosphorus sustainability at the global scale. At the same time, it aims to prime the international scientific and policy communities to co-develop the next steps towards a durable international process on phosphorus science support to policy. The OPF network is a global network of academic, industry and government actors formed through their contributions to the OPF project. Their collective expertise represents a valuable knowledge resource to this project. The OPF project was delivered through a partnership between the UKCEH and the University of Edinburgh, UK, and was funded by the UK Natural Environment Research Council (NERC) (NERC; award number NE/P008798/1), with support from the European Sustainable Phosphorus Platform (ESPP), the United Nations Environment Programme (UNEP) and the GEF Towards an International Nitrogen Management System project (described below; GEF project ID: 5400).

The uP-Cycle project responds directly to the findings of the OPF project, which include the need for integrated phosphorus management for the protection of freshwater and coastal ecosystems and to address international interactions that drive phosphorus cycles from national to global scales. The expertise of the OPF Network will form an important evidence base from the academic community to inform Component 1 and 4 activities, on delivering the global baseline emissions data and in interpreting these in consultation with key stakeholders to inform the international policy community.

The UNEP Global Programme of Action for the Protection of the Marine Environment from Land-based Activities and its Global Partnerships

The Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA) was created as a unique intergovernmental mechanism to counter the issue of land-based pollution. The GPA, adopted by 108 Governments, and the European Commission in 1995, is a voluntary, action-oriented, intergovernmental programme led by UNEP. Between 2009 and 2013, GPA created three global multi-stakeholder partnerships. These are the Global Partnership on Nutrient Management (GPNM), (launched in 2009), The Global Partnership on Marine Litter (GPML), (launched in 2012) and The Global Wastewater Initiative (GWI) (launched in 2013). The GPNM supports the GPA in addressing the challenge of nutrient excess or deficits and the potential negative impacts on the marine and terrestrial ecosystems, by sharing information globally and encouraging the adoption of improved nutrient management practices. The mandate to address particularly marine pollution and the creation of hypoxic zones associated with nutrient runoff was affirmed by countries at the 2012 Inter-Governmental Review of the GPA under the Manila Declaration. Based on this mandate, the GPNM under support from UNEP has mobilized resources from various donors, but most significantly from the GEF to execute the Global Nutrient Cycling Project (outlined above). In 2013, came the publication of *Our Nutrient World*, which linked a cross-cutting analysis of mitigation opportunities with scenarios of the potential economic benefits, which focused on nitrogen. To give special attention to the global phosphorus sustainability challenge, in November 2015, the GPNM established a specific Phosphorus Task Team (PTT). Its inaugural meeting was held later the same year in Edinburgh, UK. The GPNM is directed through its international Steering Committee, with membership from academia, government, and industry. The GPNM acts as a conduit for strategic advocacy and cooperation at the global and regional levels to provide information and enhance capacities to design and implement effective management policies to address the growing problems of nutrient over?enrichment. It sets out to achieve this overarching aim by focusing activities in the following areas: (1) contributing to the development of knowledge (policy & technical) products to inform decision making amongst policymakers, professionals, farmers, private sector; (2) providing support for piloting and replication of appropriate pilot solutions and best management practices (BMPs) for sustainable nutrient management and pollution reduction with a focus on developing countries, sharing lessons from developed countries; (3) generating awareness resources and social marketing tools and facilitating easy dissemination (via the GPNM platform and other ICT tools) to influence farmers, extensionists, policymakers and other stakeholders to drive change in behaviours and practice; and (4) contributing to the continued strengthening of the GPNM to facilitate expanded global and regional partnerships.

The uP-Cycle project will support the strategic goals of the GPA, including the GPNM, by identifying opportunities to reduce nutrient pollution impacts on terrestrial and marine ecosystems. We will work with GPA to engage with public and private stakeholders operating at the global scale in Component 4. Our outputs will be used to contribute to the GPNM, for example, as it works to raise awareness of the issues of nutrient sustainability through the global policy framework, and our outputs in Component 1 and 4 will be designed to increase the capacity of the GPA to influence international action on addressing environmental impacts associated with an unsustainable global anthropogenic phosphorus cycle.

UNEP coordinated World Water Quality Alliance

United Nations Environment Assembly (UNEA) Resolution 3/10 on ?Addressing water pollution to protect and restore water-related ecosystems? (UNEP/EA.3/Res.10) requested UNEP to develop a global water quality assessment in collaboration with UN-Water and relevant stakeholders by UNEA-5. During the Inception Meeting for the Assessment, around 50 organizations (UN, research, civil society, private sector), which had expressed interest to engage in the assessment, also expressed interest to work with UNEP in co-designing agendas and action around emerging issues. This group formed the World Water Quality Alliance (WWQA) as an open community of practice, representing a voluntary and flexible global Expert, Practitioners and Policy Network, which advocates the central role of freshwater quality in achieving prosperity and sustainability. It explores and communicates water quality risks in global, regional, national and local contexts and points towards solutions for maintaining and restoring ecosystem and human health and wellbeing. It aims to serve countries throughout the lifetime of the 2030 Agenda for Sustainable Development and beyond. UNEP, and more specifically the Global Environment Monitoring Unit in the Science Division, acts as a Coordination Unit for the Alliance. The WWQA activities include use-cases on Lake Victoria and the Volta River Basin Transboundary Systems. The WWQA Ecosystem Work Stream led by a core group of UKCEH, IHE-Delft, World Bank Group, Wageningen University, UNEP, and JRC works directly with lake restoration practitioners to support the development of novel restoration programmes focusing on delivering socio-economic and environmental gains, especially in developing economies where data availability is sparse. The WWQA is engaged with UNEP Water focused on improving nutrient emissions reduction indicators within SDG 6.3.2.

The uP-Cycle project will support the strategic goals of the WWQA by developing the uP-Cycle Community of Practice Network, enhancing the WWQA membership with a focus on delivering effective ecosystem restoration (including Transboundary ecosystems), and utilising WWQA data products (e.g., World Water Quality Assessment Reports) and expertise to inform activities in Components 2 and 3. The project will engage with the diverse group of WWQA Workstreams to address specific knowledge needs in Component 3 and we will establish the WWQA Ecosystems Workstream as a long-term coordination mechanism for the community of practice.

International Lake Environment Committee Foundation

The International Lake Environment Committee Foundation (ILEC) was established in 1986 by Shiga Prefecture, Japan, and was authorised as an incorporated foundation by the Government of Japan. ILEC seeks international knowledge exchange and research promotion to develop sustainable management of the world lakes and reservoirs. It has a continuing mission to enhance international cooperation for conserving lake environments and promoting environmentally sound management of world lakes through encouraging investigations and research. ILEC continue to provide a global coordination and knowledge exchange platform supporting the Integrated Lake Basin Management approach, working with UNEP and other relevant UN agencies in this pursuit, and providing a conduit for knowledge exchange between lake basin catchment managers through their World Lakes Conference and joint activities of their voluntary Scientific Committee.

The uP-Cycle project will learn from the experiences of the ILEC, drawing on the capacity development and educational materials previously produced for the implementation of the Integrated Lake Basin Management Approach to inform the development of the uP-Cycle Framework and Monitoring and Assessment Approach (Component 2 and 3). ILEC will also be engaged in establishing the Community of Practice Network drawing on their previous experiences in establishing global networks of practice and supporting future related engagement activities (including the World Lakes Conference).

The Committee on Fisheries ? and its Sub-Committee on Aquaculture

The Committee on Fisheries (COFI), a subsidiary body of the FAO Council, was established by the FAO Conference at its Thirteenth Session in 1965. The Committee presently constitutes the only global inter-governmental forum where major international fisheries and aquaculture problems and issues are examined and recommendations addressed to governments, regional fishery bodies, NGOs, fishworkers, FAO and the international community, periodically on a worldwide basis. COFI has also been used as a forum in which global agreements and non-binding instruments were negotiated. COFI membership is open to any FAO Member and non-Member eligible to be an observer of the Organization. Representatives of the UN, UN bodies and specialized agencies, regional fishery bodies, international and international non-governmental organizations participate in the debate, but without the right to vote. The Committee has held 31 sessions. The First Session in 1966, and thereafter annually till 1975. Since 1977 the sessions have been held biennially. COFI has established sub-committees on certain specific issues, for example, the COFI Sub-Committee on Trade and of particular relevance to this project, the COFI Sub-Committee on Aquaculture. The Sub-Committee on Aquaculture provides a forum for consultation and discussion on aquaculture and advises COFI on technical and policy matters related to aquaculture and on the work to be performed by the Organization in the subject matter field of aquaculture. The Sub-Committee is tasked with identifying major issues and trends in global aquaculture development and makes recommendations for international action to address aquaculture development needs. Further roles include advising on the preparation of technical reviews and of issues and trends of international significance and addressing any specific matters relating to aquaculture referred to it by its Members, the Committee on Fisheries or the Director-General of FAO.

The uP-Cycle project will engage with COFI through the Sub-Committee on Aquaculture to raise awareness of the need for improving phosphorus use efficiency within aquaculture activities globally (Component 1) supporting the co-development of guidance on reducing the impact of phosphorus emissions on lakes (e.g., Lake Villarrica) and connected ecosystems, and supporting sector-specific dissemination and engagement at the lake basin and country scales in Component 3.

National and regional phosphorus sustainability innovation platforms

A range of knowledge exchange partnerships exists across various countries and regions with little international coordination. They include the European Sustainable Phosphorus Platform (ESPP), The Sustainable Phosphorus Alliance ? North America (SPA), the Global Phosphorus Institute, The Dutch Nutrient Platform, The German Phosphorus Platform, The Swedish Sustainable Nutrient Platform, The Irish Nutrient Sustainability Platform, and the Phosphorus Industry Development Organization of Japan.

The uP-Cycle project recognises the community of Innovation Networks that, collectively, represents an international resource providing direct access to innovations in the field of phosphorus sustainability to a global audience of industry, practitioners, regulators, and policymakers. We will work with the coordination teams of these networks to develop the uP-Cycle Innovations Hub (Component 4) designed to address the disconnect between restoration practitioners and leading innovators in the field. We will utilise the wide reach of the Innovations Networks to enhance the dissemination of our outputs.

The Chile Baseline

Background: Chile?s location and latitudinal span determine one of the most extremely variable climatic settings worldwide, from north-to-south precipitation increases and temperature decreases. As such, Chile?s rivers and lakes exist in highly diverse geographical settings, from the driest desert on earth to Patagonia, and are characterized by extraordinary biodiversity. Lake Villarrica (Lago Villarrica) in the Region de La Araucan?a (Araucan?a), is in the South of the country. Araucan?a, "the granary of Chile", has become one of the principal agricultural districts of Chile. Tourism is also a growing industry in the region; the main tourism center surrounds Villarrica Lake and the city of Puc?n. Agriculture, aquaculture and tourism in Araucan?a, and Chile more generally, are heavily reliant on clean lakes and healthy freshwater ecosystems. A significant challenge to water managers, who must balance increasing water demand against the need for water security, is how these ecosystems, and the services they provide, will respond to increasing phosphorus pollution, especially in light of global change processes (e.g., climate change and economic and population growth). Chile?s economy is reliant on agricultural exports that are also highly reliant on water, such as mining and agriculture. Agriculture, driven especially by export crops, is growing rapidly. This follows the declaration of the goal for Chile to become a world agricultural and food production power in the twenty-first century, which will require an increase of the total area under irrigation by at least 36%.

Agriculture is a major source of phosphorus pollution to water bodies in Chile. Tourism is also a growing industry in the region and will be severely impacted by the failing water quality of the countries lakes. Indeed, water quality is at the center of water conflicts and the sustainability agenda in Chile. Access to sanitation and safe and sufficient water is the obvious starting issue. However, the interdependencies of socio-environmental systems also prompt the need for public policy and decision making in issues related to water quality and food, ecosystem services, natural patrimony, and environmental justice. A decrease in the water quality (e.g., due to increasing phosphorus emissions) of lakes in Central-Southern Chile is being observed, with the onset of eutrophication and algal blooms.[22][22] Those lakes include Villarrica, Llanquihue, Caburgua, Calafqu?n and Ri?ihue. This may be explained by a combination of land-use change, expansion of urban areas, deforestation, exotic plantations, and regional climate change such as decreased rainfall and rapid melting glaciers.[23][23] Evidence for eutrophication in oligotrophic lakes in Central Chile has also been identified, risking biodiversity loss across a wide range of endemic freshwater species.[24][24]

This increasing trend of cultural eutrophication indicates an increasing trend in phosphorus (and nitrogen) loading from land-based activities to the Humboldt Current Large Marine Ecosystem (HC-LME). During the development of the Humboldt Current Large Marine Ecosystem Strategic Action Programme (see below under GEF Activities) the mortality of marine species within the HC-LME has been identified as a priority concern. Immediate causes include ?eutrophicated areas due to the increase of nutrients with the presence of algal blooms and oxygen depletion, and harmful algal blooms.?, related to the underlying cause of ?improper use of agrochemicals and fertilizers that increase the amount of nutrients in the receiving marine environment.? Whilst Chile has greatly enhanced its water quality monitoring programme in recent years, for example, in response to the SDG 6 Data Drives, significant gaps in nutrient emissions and impacts at the national scale remain to be resolved, especially for lakes and reservoirs [25][25]. There is a pressing need to develop such a national system, drawing on international experiences and from emerging in-country emissions reduction programmes which, to date, have been focused on lake basins assessed as being most at risk from cultural eutrophication (e.g., the Lake Villarrica Basin outlined below).

Governance of Chile?s Water Resources

Following decentralization and market reforms in the 1970s, the water sector in Chile underwent major changes. This led to the Water Code of 1981, which is the main regulation governing terrestrial water use and water rights in Chile. Under the Water Code, water is considered national property for public use and neither appropriable by the state nor directly by individuals. The Water Code grants permanent and transferable ?water rights? to individuals, for consumptive or non-consumptive use, to be exercised continuously or discontinuously. Once water rights have been granted, they fall under the jurisdiction of private civil law, rather than administrative law. Importantly, water rights are transferrable. The aim is to achieve an efficient allocation of water through market transactions of water rights. The management of water rights is conducted under a dual water institutional system. Firstly, through a centralised administration exercised by the National Water Directorate; tasked with authorising transfers of water rights to protect potential negative impacts on third parties. Secondly, through decentralized management, corresponding to users (e.g., private organisations), collectively organised in each river basin in ?*Water User Associations?*. Water User Associations manage and distribute water at the local level and are not part of the State administration. In 2013, the World Bank identified 43 institutional actors/stakeholders involved in the management of water resources in Chile.[26][26]

The Water Code is mainly focused on water quantity and allocation, and not water quality and ecosystem protection. However, a reform in 2005 established the requirement for ?minimum ecological flows?. This was reinforced with the 2010 reform of Chile?s Environmental Law, Law 19,300, which regulates the protection of aquatic ecosystems through the implementation of ecological water flows. Chile?s water quality regulatory system is led by the Ministry of Environment, since its creation in 2010, and is mainly regulated by the Law N? 19.300 of 1994, the Law N?20.417 of 2010 and the Law N? 20.600 of 2012. The basic regulatory water quality instruments are: (a) environmental water quality standards, (b) decontamination plans and strategies, (c) emission standards, and (d) environmental impact assessments for new investments.

Despite considerable advances in water quality monitoring in Chile, advances in decision making and public policy are still hampered by insufficient data and poor integration of process understanding.[27][27] Chile?s General Water Directorate (Direcci?n General de Agua (DGA)) is the public entity responsible for promoting water resource management and providing and disseminating information on the water quality of Chile? freshwater resources. The DGA inventory includes 101 watersheds with 1,251 rivers, 12,784 lakes, and 24,114 glaciers (as reported in 2018 [28][28]). The DGA monitoring network for water quality includes 829 stations, for streams, groundwater, and lakes and reservoirs (252 located in Southern Chile). For each site, 1?12 samples are taken annually, depending on operational definitions and constraints (typically 3 for streams and groundwater and 2 for lakes and reservoirs). In a report by the DGA, in 2014, about 39% of the 101 watersheds in the DGA inventory were not actively monitored, 19% had 1 water quality monitoring station, and only 19% had 10 or more water quality monitoring stations.[29][29] The Chilean monitoring network includes sampling and analyses of nutrients for lakes and reservoirs. Whilst this limited lake monitoring network focuses on assessing the trophic state of lakes through the measurement of phosphorus, nitrogen and chlorophyll-a in the water column, it is not the only source that reports measurements of water quality parameters. Other sources of water quality information include:

? *Secondary water quality standards surveillance plans*. Several watersheds, including Villarrica, have implemented secondary water quality standards (known as NSCA), which include a predefined set of parameters, locations, and monitoring regimes.

? *Environmental impact assessment platform*. The Chilean law 19.300 *Bases for the Environment*, which enacts the Environmental Impact Assessment System (SEIA) requires that new investment projects or modifications conduct an environmental impact assessment. When activities entering the SEIA have the potential to impact water, they are required to consider a water quality baseline and a water quality surveillance program (data may be available on request).

? *Superintendence of Sanitary Services (SISS)*. According to the Chilean concession system, all water companies that provide drinking water and wastewater treatment are required to comply with drinking water and treated wastewater discharge standards, (data may be available on request).

? *Superintendence of Environment (SoE)*. According to Chilean law, all companies that discharge industrial wastewater into surface, underground or marine water bodies, are required to comply with Industrial Effluent standards. Also, projects approved by the SEIA that include a water quality surveillance program must periodically submit Environmental Monitoring Reports to the SMA (data available on the SMA website).

To support the implementation of SDG indicator 6.3.2, ?Proportion of bodies of water with good ambient water quality? the Chilean Direcci?n General de Aguas (DGA, the Chilean water agency) reported on monitoring data across 989 surface water monitoring stations (excluding lakes and reservoirs) and groundwater resources. This data resource represented over 1 million data records including basic parameters (pH, electrical conductivity, dissolved oxygen, temperature), ions (e.g. Ca, Mg, Na, K, SO4, Cl), total metals (e.g. As, Al, Cu, Fe, Mn, Pb), nutrients (nitrogen and phosphorus) and organic compounds (BOD51 and COD2) (CEDAS-DGA, 2020). Following the guidance of UN-Water in the methodology for indicator 6.3.2, the DGA has identified hydrological units in the form of basins and sub-basins as well as surface water body type (surface streams, lakes, reservoirs, groundwater aquifers), defining the boundaries of 101 basins at the national scale.

Chile does not, yet, have an integrative water quality ?clearinghouse? that takes advantage of these different monitoring programmes and data resources or collates such data from miscellaneous data sources with respect to nutrient emissions to surface waters or loads through the basins to the coast. The current approach to water quality is mostly statistical, without systematically supporting conceptual and quantitative models helping to frame data interpretation. An improved approach for water quality monitoring and data management and interpretation, including the use of ecosystem-based process modelling, is required which should be coherent with an integrated watershed management approach.

Phosphorus Management in the Villarrica Catchment.

Villarrica Lake Basin includes several tributaries to the lake. The ?Trancura River? contributes about 90% of the tributary runoff water that the lake receives. Villarrica Lake is a sub-basin of the Tolt?n River, it has a surface area of ??2,805 km2 and includes the communities of Villarrica, Puc?n, Curarrehue and Cunco. This basin includes two main lake bodies, Villarrica Lake and Caburgua Lake.

The lake is a major tourist attraction of the City of Puc?n where eco-tourism is a key industry on the east shore and Villarrica to the west where salmon farming, agriculture and forestry are key industries.

Nutrient discharge from rivers in this zone can contribute to enhancing biological activity in coastal waters, which sustain local ecosystems during periods of minimum or delayed seasonal upwelling (winter and early springs). Studies in this area have shown that high concentrations of chlorophyll-a in rivers are accompanied by increased primary production in coastal waters[30][30]. This is also expected for Tolt?n river discharge. Although there is no demonstrated connection between the Tolt?n river (small catchment) and the Humboldt current LME, it is evident that the nutrient load from this lake flows into this critical LME, which according to the TWAP[31][31] is impacted by large amounts of nitrogen loading entering coastal waters from human activities in watersheds. Additionally, according to the International Waters Program Study conducted in 2002[32][32], there is an ongoing need in South America to give opportunities to developing country-driven projects that address dominant problems in the smaller catchments draining regions to the west of the Andes.

The Decontamination Plan for Villarrica. In 2017, the Chilean Government declared Lake Villarrica as a ?saturated zone? due to poor water quality, which included exceeding chlorophyll a, transparency, and dissolved phosphorus limits established in the Villarrica Lake Secondary Water Quality Standards (Villarrica Lake NSCA). This has resulted in the initiation of The Decontamination Plan for Villarrica. On May 25th, 2020, the official draft of the Villarrica Basin Decontamination Plan was published, starting with a public consultation process. An Indigenous Peoples Consultation Process is underway. All observations provided by citizens, indigenous people and public services will be answered by the Environmental Ministry Team and an official final version of the Villarrica Basin Decontamination Plan is expected to be published during the uP-Cycle project.

Phosphorus pollution to Lake Villarrica is above critical thresholds. Around 303 tonnes of phosphorus and 1438 tonnes of nitrogen year^{-1} enter Villarrica Lake. The phosphorus load is 1.54 times greater than the Villarrica lake critical load, which was defined as the maximum load that the lake can receive to maintain its trophic status, beyond which ecosystem damage is inevitable. Point sources and nonpoint sources identified in the official draft of the Villarrica Basin Decontamination Plan include aquaculture (38.2% of the total phosphorus load), the Puc?n wastewater treatment plant (1.2 %) and Non-Treatment of Currarrehue Town Public Sewage System (1.6 %). Nonpoint sources identified include septic tanks (2.7% of the total phosphorus), natural runoff (45.1%), and forestry/agricultural runoff (land-use changes;11.2%).

Plans to reduce phosphorus pollution to Lake Villarrica: The goal of the Decontamination Plan is to reduce emissions to meet the limits established in the Villarrica Lake NSCA through measures including the implementation of treatment systems in rural and urban areas of the basin and the reduction of emissions of nutrients and sediment/soil losses through forestation, reforestation and restoration of the riparian vegetation. In addition, the development of emission standards for total phosphorus loading from aquaculture and sewage treatment plants located in the basin have been proposed, alongside other management measures aimed at protecting and maintaining the ecosystem services provided by the lake. Collectively, and if effective, these measures have been estimated to result in a reduction of the phosphorus load by 109.2 tonnes per year, representing about 30% of the total load to the lake. The main measures will be implemented in the first three years following the publication of the official final version of the Villarrica Basin Decontamination Plan, which seeks to recover the limits established in the Villarrica Lake NSCA in a maximum period of 15 years. A General Analysis of the Economic and Social Impact of the cost and benefits of the plan was developed in the official draft of the Villarrica Basin Decontamination Plan, which estimated benefits of USD 1,892 million from an investment in emissions reduction measures of USD 104 million.

It should be noted that the phosphorus load estimates, impact of measures, costs and benefits showed in this document are part of the official draft of the Villarrica Basin Decontamination Plan and may be modified in the final version of the Villarrica Basin Decontamination Plan.

Opportunities identified through initial discussions in the PPG proposal drafting stages

? Adopting integrated water resources management is a priority for Chile; currently, few integrated approaches bring together public, private, and civil society and different sectors rarely interact even when part of the same water user associations.

? Chilean lakes and reservoirs are not sufficiently protected from phosphorus pollution, with little mention of phosphorus pollution impacts in policy or regulation.

? There is a pressing need for enhanced data collection on sources of phosphorus loading to lakes (agricultural and private sewage system (i.e., septic tanks) diffuse pollution; and treated wastewater and fish farming effluents are prime suspects for nutrient discharges).

? There is a need to enhance institutional capacity to strengthen baseline phosphorus emissions data and identify impacts to support the identification of emissions reductions measures.

? There is a requirement to better understand and access tools that can predict ecosystem impacts in response to phosphorus pollution and its mitigation. This information is critical to argue for more stringent standards on phosphorus pollution and to ensure maximum benefits are equitably realised from planned investments. In addition, it will better inform on the nature and extent of ecological and ecosystem service response following costly emissions reductions investments across sectors.

? There is a need to improve understanding of nutrient loading from land-based activities to the coats, to support the objectives of the HC-LME SAP, and a national surveillance and/or nutrient emissions modelling approach is required to inform the need for national scale nutrient load reduction.

Chile ? relevant GEF supported projects

There are many important efforts past and current *(coordination with the ongoing SAP implementation project is highlighted in the coordination section below)* that the GEF has invested in this region specially to improve the ecosystem health of the Humboldt Current Large Marine Ecosystem (HC-LME).

Towards Ecosystem Management of the Humboldt Current Large Marine Ecosystem ? GEF Project ID ? 3749, implemented by UNDP and executed by IFOP, IMARPE. 2009 ? 2016.

This project aimed to advance ecosystem-based management (EBM) in the HC-LME through a coordinated framework for improved governance and the sustainable use of living marine resources and services. To promote an Ecosystem-Based Management (EBM) of the HCLME, the Governments of Peru and Chile agreed to co-finance, with GEF, the above project. The management and implementation of this project were carried out with the support of the United Nations Development Program and the United Nations Office for Project Services (UNOPS) through a binational Regional Coordination Unit (RCU). The focal points were the Institute of Fishing Promotion (IFOP) in Chile and the Institute of the Sea (IMARPE) in Peru. The project formed a Technical Working Group for each country who co-produced an Ecosystem Diagnostic Analysis for each country, a Transzonal Ecosystem Diagnostic Analysis and the HC-LME Strategic Action Programme. Of relevance to uP-Cycle is the outcome of the Ecosystem Diagnostic Analysis which confirmed nutrient loading as a result of land-based activities is a contributing factor to mortality in marine species through eutrophication of receiving coastal waters.

Catalysing Implementation of a Strategic Action Programme for the Sustainable Management of Shared Living Marine Resources in the Humboldt Current System (HCS). GEF Project ID ? 9592; 2017 ? ongoing.

Implemented by UNDP and executed by IFOP, IMARPE, SUBPESCA, PRODUCE, MMA, MINAM, SERNAPESCA, SERNANP, this project aims to facilitate ecosystem-based fisheries management (EBFM) and ecosystem restoration in the HC-LME for the sustainable and resilient delivery of goods and services from shared living marine resources, in accordance with the HC-LME SAP-endorsed by Chile and Peru. The proposed project contributes to the SAP objective on ?Improve the environmental quality of the coastal and marine ecosystems through integrated management, considering different pollution sources.? The uP-Cycle project will consider the lessons learned from this project and will contribute to the SAP objective *?Improve the environmental quality of the coastal and marine ecosystems through integrated management, considering different pollution sources.?* To do this, we will work with the Chilean Ministry for Environment (Component 3), who work in contact with the relevant bodies in Chile and Peru, to develop the first national-scale nutrient emissions tool with which to assess the effects of future land-management scenarios on eutrophication impacts of the HC-LME.

Mainstreaming Conservation of Coastal Wetlands of Chile?s South Center Biodiversity Hotspot through Adaptive Management of Coastal Area Ecosystems ? GEF Project ID 9766.

Implemented by UNEP and executed by the Chilean Ministry for Environment 2019-2024, this project aims to improve the ecological condition through the sustainable management of coastal ecosystems in south-central Chile. In these ecosystems, the aim is to implement good practices and environmental aspects in different productive sectors, supporting local development through sustainable management, raising awareness on the need to reduce the pressures on these habitats occupied by various native and migratory species with different problems of conservation, and reduce threats and pressures on the relevant hydrographic basins. The project takes into consideration the results of the restoration pilot experience implemented in Demonstrative Wetlands that includes good practices and environmental criteria for production sectors; reforestation/afforestation; erosion control measures, among others. Lessons learned from this project in establishing relationships with public services, protocols for integrated sustainable land management and key biodiversity conservation in wetlands, among other topics will be utilized in the uP-Cycle project, and through direct collaboration with the Chilean Ministry for the Environment.

Economic instruments and tools to support the conservation of biodiversity, the payment of ecosystem services and sustainable development ? GEF Project ID 10213- Implemented by UNDP and executed by Chilean Environmental Ministry, 2021-2025.

This project aims to improve national financing of biodiversity through the design, implementation and optimisation of market-based economic instruments (IECB) that reinforce public financing and facilitate the economic contribution of the private sector to maintaining Chile?s natural capital. The proposed project will take into consideration the results and lessons learned from the Institutional framework proposed, including Technical IECB guidelines and proposals for regulations for their application, monitoring and evaluation in freshwater environments. The multi-sectorial coordination mechanisms with the participation of public and private stakeholders, governance models will be assessed. Project models founded on Nature-based Solutions recognized as eligible green expenditures will be identified and the results and lessons learned from pilot experiences in coastal wetlands will be shared. The uP-Cycle project will learn from the development of the Nature-Based Solutions and Natural Capital approaches developed for Chile in the project and will work to integrate these and build on them with a focus on achieving phosphorus emissions reductions, as well as multiple added benefits.

3. The proposed alternative scenario with a brief description of expected outcomes and components of the project

Overview of Project Approach and Theory of Change.

The uP-Cycle Project has been developed to address the barriers (**B**) outlined above. To address the issue of insufficient phosphorus emissions and impacts surveillance data (**B1**), the project will deliver, in Component 1, a global model output (i.e., The Global Phosphorus Emissions Dashboard) producing export estimates from land to freshwater to sea, with basin-scale resolution, and capacity to predict the effects of future mitigation and environmental change scenarios. To inform development and optimisation of phosphorus emissions reductions programmes, for example, to benefit transboundary lakes or LMEs requires a scalable, ?drag-and-drop? Framework and this will be developed in Component 2 learning from a new Community of Practice focused on sustainable phosphorus management for the benefit of lakes and their communities (**B1 & B2**). The optimization of existing phosphorus emissions reduction programmes will be achieved through a dedicated Monitoring and Assessment Approach aligned with existing global frameworks (e.g., associated with SDG Indicator 6.3.2; **B3 & B4**). This approach will be piloted in Chile (Component 3), where on-the-ground activities will be implemented to address the recognized need for better integration of existing data and monitoring systems, and applied across the uP-Cycle Community of Practice (Component 2) to raise awareness across the global public and private sectors on the potential to release environmental and socio-economic benefits for communities reliant on healthy lake ecosystems (**B3**). Finally, an overarching outcome of the project will be to increase awareness of the opportunities of improving the integration of sustainable phosphorus management across the global policy arena through engagement with key global stakeholders (Components 1 and 4; **B4**).

Description of expected Components, Outcomes, Outputs and Activities.

***Component 1*. Increasing clarity on global phosphorus emissions, drivers and impacts leading to increased awareness of global scale sector-specific phosphorus emissions reductions opportunities.**

In Component 1, working with the WRI and PBL, we will produce a ?Global Phosphorus Emissions Dashboard? through which modelled emissions at basin to national and regional scales and their drivers may be interrogated (O 1.1.1). The Global Phosphorus Emissions Dashboard will inform policy development priorities through multi-sectoral workshops, working with the GPNM to identify sector-specific emissions and their international drivers at the global scale (O 1.1.2). The workshops may utilize the Global Phosphorus Emissions Dashboard to provide context around real-life case studies with which to examine the capacity to reduce emissions to specific transboundary ecosystems, aligning with other GEF investments. We will engage and inform International Industry Associations (see Section 10) who hold key roles in influencing institutional policy changes to accelerate sustainable phosphorus use across scales, towards a coherent global approach on sustainable phosphorus management (O 1.1.3).

Outcome 1.1. Global stakeholders have the evidence needed to assess the capacity for phosphorus emissions reductions to contribute to their commitments to delivering large-scale ecosystem restoration ambitions (e.g., the UN Decade and SDGs). Improved international and cross-sector awareness of the need for coordinated action to deliver large-scale phosphorus emissions reduction.

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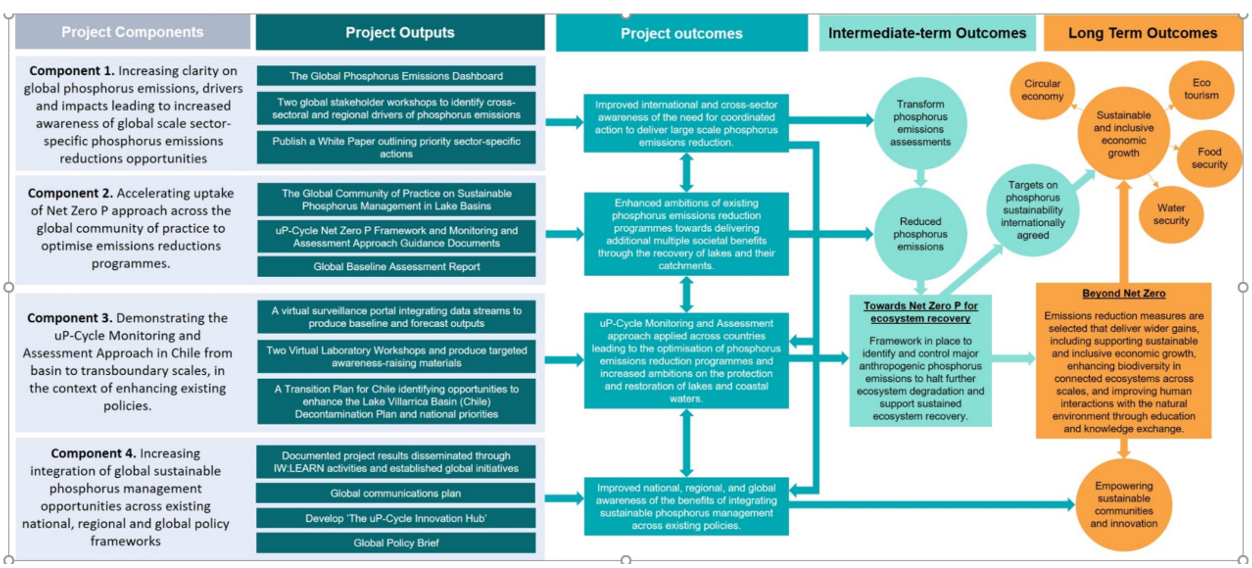

Figure 2. Components, Outputs, Outcomes and the uP-Cycle Theory of Change. The project will be composed of four Components operating across basin, national, transboundary, and global scales. The project design recognises that success in reducing emissions at the basin to national scales (Component 2 and 3) may require interventions to address drivers of emissions at the transboundary to global scales (Component 1 and 4). To achieve this requires improved international awareness on the need for coordinated action on phosphorus emissions reduction

(Outcome 1.1) leading to enhanced ambitions across existing and emerging emissions reduction programmes (Outcome 2.1). It is important to demonstrate that such transitions can be achieved through engagement with countries where phosphorus emissions are increasing but where existing policies do not yet reflect the need for such a transition (e.g., Chile, Outcome 3.1). Finally, raising awareness of the benefits of more sustainable phosphorus management will be key to accelerating international action (Outcome 4.1). These outcomes will deliver improved assessments of phosphorus emissions and their impacts and will support countries as they develop mitigation plans to protect and restore impacted ecosystems, i.e., in response to the UN Decade on Restoration and the UN Sustainable Development Goals. In the longer term, they will underpin transition plans towards more sustainable phosphorus economies enabling greater food security whilst releasing new economic development opportunities.

Description of Proposed Outputs:

Output 1.1.1. The Global Phosphorus Emissions Dashboard beta version developed and implemented as an open source online mapping tool allowing visualization of emissions estimates and their contribution to eutrophication risk across the world?s large lakes, extending to coastal waters.

•The dashboard will combine modelling data products to produce maps of phosphorus emissions from land-based sources allowing interrogation of emissions estimates and their geographical and cross-sector sources to be identified across scales, from lake basin to national and global scales.

Output 1.1.2. Two global stakeholder workshops demonstrating the Dashboard and inform discussions on cross-sectoral drivers of global phosphorus emissions to freshwater and coastal ecosystems, as well as opportunities to address them.

•This component will deliver two workshops to showcase and further develop the Dashboard through engagement with key global stakeholders. Workshops will bring together those communities who are responsible for reducing emissions to protect ecosystems and those who are responsible for industries who can influence institutional behavioral change to accelerate emissions reduction policies within their respective sectors. These will include, but not be limited to, representatives from global environmental authorities (e.g., UNEP, World Bank, FAO) and International Industry Associations representing a ?community of influence? across key emissions sectors including agriculture, food waste, aquaculture, wastewater, and nutrient recycling sectors.

Output 1.1.3. Publish a White Paper outlining priority sector-specific actions towards delivering a more sustainable global anthropogenic phosphorus cycle to support improved food security while delivering on global ecosystem protection and restoration ambitions.

•The White Paper will be designed to support International Industry Associations and global environmental authorities in their role as ?influencers? of behavioral change at national and international scales. In the report, we envisage that the global business case for improving phosphorus sustainability will be made, providing economic context on the benefits of phosphorus recycling as well as potential savings associated with investments in emissions reduction measures leading to ecosystem recovery.

Proposed Activities:

•Drawing on multidisciplinary and cross-sector expertise, establish a Global Phosphorus Emissions Assessment Group, bringing together data providers with which the global extent of emissions and their impacts on freshwater and coastal ecosystems can be mapped.
•Develop existing web-based infrastructure (e.g., WRI Aqueduct Water Risk Atlas) to host and integrate relevant global data streams producing the Global Phosphorus Emissions Dashboard. The Dashboard will be designed to allow interrogation to produce cross-sector emissions estimates at basin, LME, national, regional and global scale resolution.
•Convene a cross-sector working group with representation across relevant global policy sectors (e.g., Figure 1) and International Industry Associations.
•Hold two workshops to showcase, and further develop, the dashboard and explore cross-country-sector influences on the anthropogenic phosphorus cycle impacting on exemplar national or basin-scale phosphorus emissions programmes.
•Produce recommendations for global actions outlining the benefits of ?Future World? policy development options and their capacity to deliver change against ?Present Day? conditions within the context of existing relevant national and international public and private policy frameworks.

Component 2. Building the Global Net Zero Phosphorus Community of Practice on sustainable phosphorus management in lake basins, producing the uP-Cycle Framework and Assessment Approach and accelerating its uptake to optimise emissions reductions programmes.

In Component 2, working with the WWQA and its members and with other global bodies of relevance, we will establish a global network of practitioners tasked with implementing phosphorus emissions reductions programmes across the world?s lakes, including transboundary lakes (O 2.1.1). This network will be an important conduit through which to raise awareness on the ground, embedding the concept of sustainable phosphorus economies across existing ecosystem restoration investments and policies. We will mobilise the community to co-develop the uP-Cycle Framework providing stakeholders and practitioners with a conceptual model, centered on the Net Zero Phosphorus concept (Focus Box 1) to support the implementation of phosphorus emissions reductions programmes across scales including consideration of impacts on coastal ecosystems. This Framework will be adapted from existing frameworks (e.g., the SDG Global Accelerator Framework encompassing Data & Information, Financing, Capacity Development, Innovation, and Governance; and the ILEC Integrated Lake Basin Management Framework) and will learn from experiences in developing and implementing Net Zero Carbon initiatives.

A Monitoring and Assessment approach will be designed to allow identification of actions required to optimize existing and emerging emissions reductions programmes (e.g., following the IUCN Restoration Opportunities Assessment Methodology). The global landscape of investments and expected benefits in this context will be estimated by applying the Monitoring and Assessment approach across the Community of Practice. This component will review experiences and increase ambitions across existing and emerging phosphorus reduction programmes, widening the scope of existing programmes to include wider benefits.

Outcome 2.1. Increased uptake of an international monitoring and assessment approach for the optimisation of phosphorus emissions reduction programmes leading to increased ambitions on the protection and restoration of lakes and their catchments and associated socio-economic benefits.

Description of Proposed Outputs:

Output 2.1.1. Convene the Global Community of Practice on Sustainable Phosphorus Management in Lake Basins; a global network of practitioners tasked with assessing the global baseline on large-scale phosphorus emission reduction programmes.

•During PPG, the Network will draw on existing members of the WWQA and will consult with ILEC and UN-Water to identify representatives from lake basin management programmes where phosphorus is a priority concern. This community will be coordinated through the WWQA. We will enhance knowledge exchange across the network through practitioner surveys, field visits (depending on Covid travel restrictions) and annual workshops.

Output 2.1.2. Guidance materials leading to international implementation of the uP-Cycle Net Zero Phosphorus Framework and Monitoring and Assessment Approach, co-developed with the Global Community of Practice.

•The Community of Practice will provide the evidence base to inform the development of the uP-Cycle Framework and Monitoring and Assessment Approach whilst also acting as a springboard to accelerate their international uptake and application. Guidance materials and common assessment methodology will be produced and disseminated to the Community of Practice through knowledge exchange workshops and through the Innovations Hub (Component 4). The Framework will set out the multiple benefits of implementing sustainable phosphorus management plans to protect and restore lake basins whilst releasing multiple socio-economic benefits. We envisage that these benefits will be aligned with the SDGs as well as targets embedded within existing and emerging national and regional sustainability policies. The Monitoring and Assessment Approach will allow lake basin managers to conduct internationally coordinated assessments of the operational effectiveness of existing programmes whilst identifying opportunities to improve them. For example, the Assessment approach will allow quantification of benefits, for example, in line with the GEF Core Indicators, providing a global baseline.

Output 2.1.3. Global Baseline Assessment Report produced and shared with countries showcasing the first internationally coordinated assessment of present-day phosphorus emissions programmes for lakes and increasing international motivation to implement new policies, programs, and/or investments leading to more sustainable phosphorus management.

•We will work with this community to conduct the first globally coordinated assessment of emissions reductions programmes. The data and information produced will be synthesised to produce a report documenting the current levels of disparity in approaches and barriers to their effective implementation, drawing on specific case studies as exemplars and utilizing lessons learned from Component 3. A global baseline assessment of costs and benefits will be included drawing on reporting against common indicators (e.g., in line with SDGs and GEF Core Indicators) and opportunities to enhance existing programmes to optimise benefits will be proposed. The report will be used to increase international motivation to implement new policies, programmes, and/or investments leading to more sustainable phosphorus management.

Proposed Activities:

•The Community of Practice will be identified and mobilized during PPG so that GEF Core Indicators and co-financing can be quantified at a high level. Conditions for inclusion of cases in the network will be set during PPG and will reflect the GEF IW Transboundary Waters focus with the inclusion of relevant Transboundary Lakes (e.g., Lake Victoria and Lake Erie already accessible).
•Coordination of the Community of Practice will be delivered by the WWQA Ecosystem Restoration Work Stream and will draw on the WWQA membership and wider multi-disciplinary networks (e.g., ILEC and others, see Baseline Section 2) to engage with representatives from lake restoration programmes delivering phosphorus emissions reduction programmes across the world.
•The experiences of the Community of Practice will be reviewed through virtual meetings and surveys to synthesise the global baseline on key challenges and solutions for achieving cross-sectoral phosphorus emissions reductions; this evidence will be used to inform the development of the uP-Cycle Framework and Monitoring and Assessment Approach.
•We will hold an open seminar series providing the opportunity for practitioners to introduce their emissions reductions programmes in detail in the context of the uP-Cycle Framework, highlighting specific challenges and solutions, with opportunities to learn from the experiences of others.
•Using surveys, we will conduct the first coordinated global assessment across our community of practice enabling the practitioner community to embed the Framework and Monitoring and Assessment Approach within their existing programmes and working closely with UNEP to ensure relevance for SDG Indicator development and integration.
•Should Covid restrictions allow, we will hold field visits designed to showcase exemplars of effective sustainable phosphorus management in established programmes.
•WWQA-Ecosystems will coordinate the publication of a long-term plan to ensure engagement with the Community of Practice beyond the lifetime of the project.

Component 3: Demonstrating the uP-Cycle Monitoring and Assessment Approach in Chile from basin to transboundary scales, in the context of enhancing existing policies.

In Component 3, working with the Chilean Ministry of the Environment, its sister departments, and their evidence providers and key stakeholders, we will pilot the Monitoring and Assessment Approach to identify areas of improvement required at the basin (i.e., Lake Villarrica) and national scales (i.e., enhancing Chile?s reporting on SDG Indicator 6.3.2, optimizing the Lake Villarrica Decontamination Plan, and supporting priority actions on decreasing land-based impacts on the HC-LME). We will work on the ground in Chile to enhance surveillance data streams (e.g., physical and remote monitoring systems) and to supplement existing data and information streams with an integrated surveillance and forecasting system. This will require training in data interrogation, visualisation, and ecosystem modelling to fully utilise all emerging information. Together, these information flows will be combined following the *Digital Twin* approach towards providing present-day and future emissions and effects scenarios to enhance decision making. This will support medium- to long-term policy development targeting ecosystem protection and restoration, whilst also identifying opportunities to release sustainable economic development.

Outcome 3.1. Improved understanding across Chilean government departments and its stakeholders on opportunities for enhancing phosphorus emission reduction programmes and policies, targeting protection of lake basins and the Humboldt Current Large Marine Ecosystem.

Description of Proposed Outputs:

Output 3.1.1. Produce a virtual surveillance portal integrating data streams to produce baseline and forecast outputs on phosphorus emissions and their impacts for the Lake Villarrica Basin, to inform the development of a national scale system.

•Improved surveillance was identified during the PIF stage as a priority need to support the existing Lake Villarrica Decontamination plan, as well as inform the development of similar plans in other lake basins in Chile impacted by phosphorus pollution. To address this need, we will work through eth Chilean Ministry of the Environment to identify data and information flows across government departments and non-governmental evidence providers (e.g., Universities, Industry and NGOs) to improve the integration and interpretation of data and information flows, enhancing these, where necessary. Enhancements may include the citizens? science and remote monitoring techniques. Recent advances in physical monitoring systems, for example, allowing integration of lake ecosystem and catchment process-based predictive models will also be considered (e.g., emissions estimates from the Global Phosphorus Dashboard in combination with the PC Lake model[1]). We envisage socio-economic data streams will be included (e.g., social deprivation and other indicators) alongside biodiversity and water quality data allowing potential benefits to be mapped. Utilising advances in data generation, interrogation, and visualisation techniques we will work to produce a virtual environment capable of assessing phosphorus emission reduction scenarios, impacts and benefits to inform stakeholder engagement and policy development. We will draw on experiences of producing similar systems within the UK.[2]

Output 3.1.2. Hold two Virtual Laboratory Workshops and produce targeted awareness-raising materials to engage stakeholders in the co-development and uptake of new opportunities for sector-specific emissions reductions at the lake basin- to national scales in Chile, utilising the surveillance portal.

•Workshops will be developed to meet the specific needs of the Chilean Ministry of the Environment and its stakeholders (to be outlined during PPG) and to develop and showcase the surveillance portal whilst also identifying synergies and opportunities to release multiple benefits through more sustainable phosphorus management along the value chain. The outcomes of these workshops will be used to develop public awareness raising materials. Content may include (1) delivering school and higher education materials to inform more sustainable choices, (2) providing guidance on the placement and benefits of nature-based solutions, (3) increasing phosphorus use efficiencies across sectors (e.g., agricultural and aquaculture), (4) increasing recycling from existing waste streams (e.g., wastewater discharges), (5) developing guidance for emissions disclosure and reward schemes, (6) supporting finance and local policy mechanisms to reduce emissions from unconnected domestic properties, and (7) exploring green investment opportunities related to increased returns through eco-tourism.

Output 3.1.3. A Transition Plan for Chile is published and shared across relevant government departments identifying opportunities to strengthen the implementation of the existing Lake Villarrica Basin Decontamination Plan, as well as improving the integration of sustainable phosphorus management across national policies for the protection and restoration of lakes and coastal ecosystems.

•We will assess the Lake Villarrica Decontamination Plan using the Monitoring and Assessment Approach. This will require detailed surveys across all relevant government departments, for example considering Data & Information, Financing, Capacity Development, Innovation, and Governance structures. Recommendations will be produced for better integration across Government Departments (see Section 8) to identify synergies and opportunities for delivery of multiple sustainability and socio-economic targets, to accelerate scaling up emissions reductions programmes, to inform nutrient emission reduction targets relevant to HC-LME SAP, where appropriate, and to raise public awareness on opportunities and benefits associated with more sustainable phosphorus use.

*Output 3.1.3 will help further develop the Lake Villarrica Basin Decontamination Plan through stakeholder engagement activities upscaling from basin to national scales. This stakeholder group (*Integrated Catchment Management Group) *will be led by the Chilean Environmental Ministry and will include representatives from the Ministries on Agriculture, Housing and Urban Planning, the National Commission for Indigenous Development, National Forest Corporation, the Agricultural Development Institute, Local Municipalities, Superintendence for Sanitary Services and the Superintendence for Environment, the Rural Sanitary Service, the General Water Directorate, General Directorate of the Maritime Territory and Merchant Marine, Chilean*

Academic Institutions, Salmon Industries, Trade and Tourism Groups, Chilean Construction Association and Civil Society Organisations and Local groups.

<u>Proposed Activities:</u>

•The application of the Monitoring and Assessment Approach will be delivered by collaborative teams, embedding international expertise across the existing catchment management groups, led by the Chilean Ministry of the Environment. These teams will compile and review evidence to produce assessment reports of existing emissions reductions programmes. Recommendations for enhancing these programmes within the uP-Cycle Framework will be co-developed during quarterly virtual workshops and *ad hoc* site visits.
•Training in the application of novel monitoring and modelling approaches and in data interrogation and visualisation techniques necessary to construct the virtual surveillance portal will be delivered through staff exchanges and directed training activities, drawing on the expertise of the UKCEH and relevant national and international partners.
•Knowledge on the implementation of innovative emissions reduction measures, including nature-based solutions, will be delivered by practitioners responsible for their implementation in other countries, for example through engagement activities in Component 2. In this way, the team in Chile will gain first-hand experience of their implementation.
•Basin and national scale stakeholder engagement will be supported by our international stakeholder community (e.g., the International Industry Associations) to provide sector-specific guidance of direct relevance to local practices, and to increase readiness levels for change.
•We will draw on the existing expertise of public engagement (e.g., social media and engagement with minority groups) across the wider project and national stakeholder group to develop and deliver clear messages on the benefits of sustainable phosphorus management considering equality and inclusion.

Component 4: Increasing integration of global sustainable phosphorus management opportunities across existing national, regional and global policy frameworks.

In Component 4, working with GEF and UNEP, the project will re-define global ambitions on the sustainable management of phosphorus for reversing freshwater biodiversity loss and creating a new path for post-pandemic sustainable recovery. We will raise awareness of these ambitions across the existing policy arena, working with established global stakeholders to address the need for intergovernmental action leading to better integration of sustainable phosphorus management across the current global policy arena.

Outcome 4.1. Improved national, regional, and global awareness of the benefits of integrating sustainable phosphorus management across existing policies within a coordinated approach (e.g., across World Water Quality Alliance (WWQA) and the Global Programme of Action (GPA); IPBES; IPCC; FAO, etc.).

Description of Proposed Outputs:

•**Output 4.1.1.** Documented project results disseminated through IW:LEARN activities (1% of the project budget) and established global initiatives.
•**Output 4.1.2.** Global communications plan to raise awareness across public, private and policy audiences, disseminated to IW:LEARN and established global initiatives.
•**Output 4.1.3.** The uP-Cycle Innovation Hub - a web-based information portal to accelerate the development and implementation of sustainable phosphorus initiatives.
•**Output 4.1.4** Publish and disseminate Global Policy Briefs to increase awareness across governments on the need for better integration of phosphorus sustainability across the existing policy arena.

Proposed Activities:

•IW Conference participation, results and experience notes developed, and documented cooperation and knowledge exchange log with (i) IW:LEARN as well as (ii) with STAP.
•We will publish a dedicated project website and conduct a media campaign (e.g., websites, web pages on government sites, and a project portal). We will increase public awareness through targeted social media activities, for example, including through the GEF and UNEP social media outlets, including short videos, webinars, surveys, and other interactive communication tools.
•By the end of the project, uP-Cycle will deliver a web-based information portal, The uP-Cycle Hub, providing access to project outputs designed to accelerate the development and implementation of sustainable phosphorus initiatives.
•We will produce annual update reports circulated to, for example, the WWQA and GPA; and through targeted special sessions at the SIWI World Water Week, the ILEC World Lake Congress, and the UN Environment Assembly (UNEA).
•Produced in collaboration with the GEF, the GPA, and the GPNM and its members, and targeting UNEA, we will deliver and disseminate Policy Briefs based on the more substantive Global Sustainable Phosphorus Strategy (Output 2.1.3) to highlight the ecosystem health and economic case for global action towards improved phosphorus sustainability governance.

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[1] see: https://www.pbl.nl/en/publications/pclake-a-process-based-ecological-model-to-assess-the-trophic-state

[2] See: https://eip.ceh.ac.uk/apps/lakes/

4. Alignment with GEF focal area and/or Impact Program strategies

This project directly supports GEF- 7 International Waters Focal Area Objective 1, "Strengthening Blue Economy Opportunities" and Objective 3, ?Enhance water security in freshwater ecosystems?. In overview, this will be achieved through the development of a robust process to create catchment management plans that safeguard not only freshwater resources (as identified in Objective 3), but also reduces the risk of downstream pollution impacts to coastal and marine ecosystems (as identified in Objective 1). This process will, in part, foster unique public-private partnerships, helping countries identify sustainable investments within the Blue Economy space and transform the private sector contributions to improved health of coastal assets (see Objective 1 in the GEF-7 Programming Directions and Policy Agenda; paragraph 183). Importantly the project will de-risk innovation in measures to address water security both in terms of quality and quantity/availability (see Objective 3; Paragraph 204). Innovations may include innovative technologies, e.g., for scalable water reuse, water efficiency, and water pollution abatement technologies and regulations (see paragraph 205).

We highlight that the Net Zero P Lakes Network and ICMGs will stimulate private sector engagement, through relevant industry sectoral roundtables and industry groups (as detailed in investments that are supported; paragraphs 186, and 202). Opportunities to deliver on the criteria identified in Objectives 1 and 3, at the national scale will be identified through the international partnerships created between the ICMGs in Chile and the Net Zero P Lakes Network, as well as through the WWQA and the national and regional phosphorus sustainability innovation networks (see paragraph 186). By facilitating knowledge exchange between these actors, the project will enhance capacity on the country level and dialogue among countries to draw conclusions from increasingly complex and innovative information sources to support decision making and to identify joint opportunities for action (as outlined in Paragraph 199). Opportunities identified will be further defined through the work of the Global Emissions Assessment Groups (Components 1) and the Integrated Catchment Management Assessment reports (see Component 3). Such outputs will enhance the quality, coverage and free availability of sound information on surface water quality and natural resources, and related grey and green infrastructure assets and adaptation deficits, thereby contributing to advanced information exchange and early warnings systems (as detailed in investments that are supported; paragraph 199). Alongside the development of the Global Phosphorus Emissions Dashboard (see Component 1), the project will provide the training, knowledge, and tools (e.g., the uP-Cycle Innovation Hub ? see Component 4) to support on the ground actions to strengthen Blue Economy Opportunities, underpinned by a Sustainable Phosphorus Economy (aligned with Paragraph 183). The roadmap will also strengthen nature-based efforts for disaster risk management, however, in this context, we extend disasters beyond drought and floods as identified in Objective 3 (paragraph 197 and 199), to include the sudden onset of toxic algal blooms, nutrient pollution and their impacts (e.g. destruction of fisheries and potable water supplies).

As highlighted in Objective 3, cooperation on water resources in most international basins to support the need for water, food, energy, and ecosystems security and increase resilience for each nation is essential. The need for transboundary cooperation, therefore, has been anchored in the SDGs as an essential element for effective integrated water resources management (SDG 6.5). However, in this context, the project has the potential to address transboundary polluting effects that are shared through marine currents (Component 1 and 4). Through Component 2 and 3 of the projects, the capacity to manage terrestrial phosphorus sources contributing to this risk will be strengthened.

5. Incremental/additional cost reasoning and expected contributions from the baseline, the GEFTF, and co-financing

Developing sustainable solutions to mitigate phosphorus pollution of lakes is a key step in effectively managing fresh waters and connected coastal waters in all regions. As established in Section 1, increasing levels of phosphorus pollution, associated with food and waste production, threaten the security of essential freshwater ecosystem services; a situation exacerbated by population growth, climate change and economic development. This is acknowledged by stakeholders in Chile, who have identified actions necessary through GEF support to develop sustainable phosphorus management programmes for the protection of freshwater and coastal ecosystems (see Baseline). This is a common story. In most nations, for phosphorus management strategies to be successful, the development of new and innovative finance mechanisms as realised through sustainable phosphorus economies (with the engagement of the private sector), is paramount. The GEF incremental funding will allow the development of a framework for sustainable phosphorus management to support economic development whilst releasing the full benefits of healthy lake ecosystems **(Component 1 and 2)**. Without the GEF increment, many low-income countries that currently lack phosphorus emissions reduction programmes, associated surveillance systems, and supporting policies will be locked into a heavily unsustainable and polluting phosphorus management pathway, resulting in further degradation of freshwater and coastal ecosystems. Lessons from high-income countries provide clear evidence on the socio-economic and environmental impacts of this pathway.

We recognize here that action at the basin to national scales requires consideration of a complex landscape of multi-sectoral interactions at the international scale. Chile provides an excellent demonstration case in this context. National and regional strategies must consider international issues that exert pressure on phosphorus sustainability at smaller scales. For example, in Chile, aquaculture and agriculture products drive major exports from the country (see Baseline) but they also drive pollution in the Villarrica Lake Basin (and other lakes) and the HC-LME. To increase the productivity of these industries, Chile relies on imported fertilisers. The globalisation of trade has created a highly connected system within which a specific country?s influence on another?s phosphorus sustainability can be obscured and is little understood. Such ?interactions? are not only influenced by societal behaviors, but also by national and regional policies, trade deals, taxes, tariffs, and legislation, which can all influence phosphorus management decisions domestically, as well as internationally. These issues are best considered in the global context, yet their impacts are felt most keenly at the ecosystem scales. These issues are poorly understood and may involve multiple countries, each with unique sustainability issues, forming a range of potential interactions. Understanding, and predicting, how these interactions may impact a country?s national phosphorus cycle is critical to developing adaptive national phosphorus strategies that are resilient to future pressures. Whilst it is acknowledged that to de-risk investments in national phosphorus strategies, there is a need for systematic identification of the relevant interactions and factors driving their change, this is beyond the remit of national and sub-national scale projects. The incremental GEF funding will allow the creation of a global network (**Component 1 and 2**) to assess critical interactions between nations that influence unsustainable phosphorus use responsible for ecosystem impacts (**Component 2**), supporting the development of a Framework and Monitoring and Assessment approach (**Component 2**) which recognises these complexities of scale within an ecosystem-based management approach and demonstrating this approach within a country where the socio-economic impacts of phosphorus pollution are increasing (**Component 3**). Without the GEF increment, the global discourse on phosphorus management will remain locked within the fallacy that ?*to sustain food provision today, requires the destruction of the environment into the future*?. This scenario is laid out in the projections of increases in phosphorus emissions to freshwaters outlined in Section 1a and will result in multiple impacts across human and environmental health, socio-economic losses and damages, and potential geo-political instability related to the international trade of phosphorus goods.

6. Global environmental benefits (GEFTF) and/or adaptation benefits (LDCF/SCCF)

The proposed project will support the GEF work under the International Waters Focal Area by addressing the causes of phosphorus pollution of fresh waters, to lessen threats to freshwater ecosystems, goods and services. It will contribute to achieving the following GEF core indicators.

GEF Core Indicator 4. Area of landscapes under improved practices: 280,500 hectares of Lake Villarrica basin (lake Villarrica surface area ? 173km2) contributing to sub-indicator 4.1 and 4.3.

GEF Core Indicator 7. While considered as a global project hence asked not to formally reflect any ?beneficiary? water body, it is believed that this project will contribute somehow to improved ecosystems health in one water marine ecosystem and one freshwater ecosystem under improved cooperative management: the Humboldt Current Large Marine Ecosystem - contributing to sub-indicator 7.3 and 7.4.

GEF Core Indicator 11. Component 3 will deliver improved management of Villarrica Lake benefitting the inhabitants (total 33,399 male and 33,239 female) and of the two major population centers of the lake, Puc?n and Villarrica communes. Population of Puc?n (2002 census): 21,107 inhabitants (10,705 men and 10,402 women). Of these, 13,837 (65.6%) lived in urban areas and 7,270 (34.4%) in rural areas. Population of Villarrica (2002 census): 45,531 inhabitants (22,694 men and 22,837 women). Of these, 30,859 (67.8%) lived in urban areas and 14,672 (32.2%) in rural areas.

The project activities aim to help countries develop sustainable phosphorus catchment management plans and meet several of the Sustainable Development Goals (SDG 1, 2, 3, 5, 6, 12, 13, 14 and 17), as discussed below. The following paragraphs outline the impact on people, the economy, and the environment, with a focus on the Villarrica Catchment in Chile.

The proposed project will work with a network of international experts to develop a process by which local governance/catchment managers are equipped and can identify the most effective and ?resources suitable? options to improve phosphorus sustainability, through the development of sustainable phosphorus catchment management plans. Whilst plans will be highly specific to the local context, generalisations can be made. For example, plans will involve placing areas of the landscape under improved practices (GEF Core Indicator 4), both to protect biodiversity (sub-indicator 4.1) and to improve land management used in agricultural production systems (sub-indicator 4.3), with the overarching aim to restore wetlands (GEF indicator 3) and maintain healthy freshwater ecosystems. The project outputs will support better cooperative management of shared water ecosystems (GEF Core indicator 7), including the active participation of Inter-Ministerial Committees (sub-indicator 7.3). The project will achieve this through the global-scale activities in components 1 and 2, by providing evidence to support the implementation of the HC-LME SAP in component 3, and through engagement with IW:LEARN (sub-indicator 7.4) (e.g., data, media and tools available from the Innovation Hub).

Component 3 may include encouraging the development of Inclusive Sustainability Innovations to maximize economic revenue supporting businesses within local communities (e.g., community phosphorus recovery/recycling opportunities). These opportunities can, for example, be designed to close gender gaps in decision-making dialogue, ensuring that socio-economic benefits are shared equitably. These aims will be embedded in the decisions making processes developed by the project (GEF Core Indicator 11).

The legacy of this project is expected to deliver improved socio-economic benefits for a range of stakeholders in the future, including:

? For lakeshore communities directly impacted by eutrophication (e.g., risks to human health, supply of food, drinking water, recreation, property values, aesthetic, spiritual and cultural benefits).

? For the wider community, within lake catchment and beyond, that are reliant on lake ecosystem services (e.g., drinking water, irrigation water, transportation, recreation, hydropower).

? For coastal communities impacted by nutrient pollution delivered from upstream freshwater catchments.

? For aquaculturists, by supporting improved (long?term) and sustainable fisheries and through relief from future risk of hypoxic waters as a result of eutrophication.

? For waste managers through access to knowledge, training and technical guidance on the management of phosphorus-rich wastes to optimize phosphorus recycling.

? For farmers through better phosphorus management policies and practices, such as access to recycled phosphorus fertiliser, and contributing to food security.

? For communities economically dependent on biodiversity and high-quality freshwater ecosystems, through improved revenue from eco-tourism.

Global Environmental Benefits for the Chile Catchment

Lake Villarrica has become one of the most important tourist destinations in Chile due to the existence of protected areas. Around 28% of Chileans choose to vacation in the communes of Puc?n and Villarrica. Around 324,000 tourists (82% Chilean, 18% foreign), came to this zone in 2017 (3 times the population of the area). Tourism is one of the main economic activities in the region of La Araucan?a, where 17,730 people worked in activities related to tourism (hospitality and food services) in 2017 and according to the latest available estimate (2007), the main communes of the basin registered an income related to tourism of USD 37 million per year.

A decrease in Lake Villarrica water quality due to increasing nutrient loads has triggered an impact on the quality and quantity of the ecosystem services provided in the basin. The high levels of nutrients produce algae blooms, which can decrease oxygen concentration in the lake, reduce water transparency, and, in some cases, increase toxins that could affect aquatic biota and/or human health due to accidental water intake, or direct contact with the skin. An increase in the frequency and intensity of harmful algal blooms have impacted foreign and national visitor numbers due to a decline in the scenic beauty of the landscape and heightened human health risks. This is negatively affecting the region?s economy due to the decrease in income related to tourism and a decrease in shoreline property values due to algal blooms.

The local economy is also reliant and impacted by inland freshwater aquaculture practices in the Villarrica Lake Basin. In Chile, there is limited regulation or monitoring of impacts in the freshwater phase stage, and there is some evidence of local eutrophication impacts and biodiversity impacts downstream of existing farms[1]. In fact, according to the draft version of the Villarrica Lake Decontamination plan, aquaculture discharges account for 38.2% of the total phosphorus load to the lake.

To gain wider access to export markets, through the main channels of modern retail and supermarkets, international markets are demanding increasingly detailed requirements on ethical and environmental criteria. The Chilean aquaculture industry recognises that further sustainable expansion relies on improving the environmental reputation of farmed salmon. Chile is a member of the Global Salmon Initiative (GSI). The GSI members are committed to improved sustainability through cooperation and transparency. The aim is to achieve standards for all Chilean suppliers, so they can achieve certification from the Aquaculture Stewardship Council (ASC), which has progressed since 2014 when Cermaq (one of the main producers in Chile) achieved ASC status.[2]

Despite the above, none of the aquaculture operators located in the Villarrica Lake Basin has the ASC standard[3], and according to the Ministry for Environment estimation, most of these farms do not comply with the maximum permissible annual total phosphorus discharge limits per metric tonne (t) of fish produced (4 kg/t of fish produced over 12 months)[4]. Through this project, a transition towards more sustainable phosphorus use in freshwater aquaculture could both reduce impacts on lakes whilst opening new international markets that demand higher environmental standards. This project provides the platform through which such innovations may be facilitated. For example, working with International Industry Associations in Component 1 may lead to the advancement of a novel ecosystem approach with clear incentives for responsible aquaculture farmers to support zoning and ecosystem monitoring to ensure sustainability and protect their investments. Also, planning at the ecosystem level may simplify permitting and ensure that farms occupy less environmentally sensitive areas.

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[1] Quinones RA, Fuentes M, Montes RM, Soto D, Jorge Le?n-Mu?oz J (2019) Environmental issues in Chilean salmon farming: a review. *Reviews in Aquaculture* 11: 375?402

[2] Gonzalez-Poblete, E.; Drakeford, B.M.; Ferreira, F.H.; Barraza, M.G.; Failler, P. The impact of trade and markets on Chilean Atlantic salmon farming. Aquac. Int. 2019, 27, 1465?1483.

[3] https://www.asc-aqua.org/map/

[4] *ASC Salmon Standard ? version 1.3 - July 2019*

7. Innovation, sustainability and potential for scaling up

Innovation: The proposed project represents a first in establishing a framework to delivering sustainable phosphorus economies based on new market and policy approaches to support the ?win-wins? of enhancing the circularity of food and wastewater systems whilst unlocking the socio-economic and biodiversity benefits of improved freshwater natural capital. This will include cost/benefit estimates of multiple externalities related to phosphorus, which will, for the first time, demonstrate the multi?focal benefits of a joined-up approach. This is critical because fundamental gaps in comparable data to describe key aspects of phosphorus sustainability make setting guidance on sustainability measures and setting targets (that are appropriate for the wide variation in phosphorus issues and resources found between nations) exceptionally challenging. Furthermore, measuring progress in achieving goals is difficult when baselines are potentially inaccurate and critical data are missing. We highlight the following broad areas in which this project innovates by addressing these issues above.

? This project will set out clear guidance on data requirements and collection methods that will support nations to collect data in ways that will allow international comparability and conformity.

The phosphorus flows for the global phosphorus cycle and a limited number of national phosphorus cycles have been estimated.[1] However, measuring, monitoring, and consolidating data on phosphorus flows is hampered by the non-comparability of datasets and missing and/or incomplete data, as recognized for example, by the recent review of progress on SDG Indicator 6.3.2. This can impact accuracy when assessing the level of risk posed by phosphorus emissions (i.e., phosphorus losses to fresh waters, vulnerability to food security risks) or identifying opportunities to improve phosphorus sustainability (i.e., potential to recycle phosphorus from wastes).

? This project will report on the socio-economic benefits of reducing eutrophication impacts.

Missing assessments detailing the extent of eutrophication, and quantification of the cost of impacts and mitigation costs, limits the development of emissions reductions programmes in many lower-income countries. However, baseline data on phosphorus emissions and eutrophication impacts necessary to underpin phosphorus management programmes are lacking in many of these countries. Without these data it is difficult to communicate the scale of the issue and, importantly when calling for policy development, to provide a cost of the damage and the benefits to the economy of implementing action. Assessments of the costs of eutrophication have been carried out in only a few countries (e.g., the USA and UK)[2].

Sustainability. The project will actively assist global partners and lake basin authorities to develop sustainable cross-sectoral partnerships (e.g., see stakeholders engaged with Lake Villarrica Basin in Section 8). The project will increase awareness of phosphorus associated risks through the Global Phosphorus Emissions Dashboard, but also importantly provide a repository of options to lessen identified risk through the Innovation Hub (a data portal on measures to improve phosphorus efficiency across sectors). The legacy of the project will be long-lasting, existing through the Innovation Hub, the Community of Practice (long-term coordination through the WWQA) and associated component outputs. Combined, the project leaves a framework with supporting tools that can be accessed by all, to support the development of catchment plans that will deliver sustainable phosphorus cycles and economies with potential for international application. These outputs and the continued support of their uptake will be coordinated by the Chilean Ministry of the Environment in Chile, and by the WWQA Ecosystems team through coordination of the International Community of Practice, the latter for at least the duration of the UN Decade on Restoration. The Global Phosphorus Dashboard will be hosted by WRI providing a legacy, and we will work to ensure its development and application into the future, supporting countries to access it through guidance documents and demonstration materials (Component 4 ? Innovation Hub). The outputs of Component 3 will be embedded within existing institutional frameworks through the Chilean Ministry of the Environment. Finally, the long term adoption of priority actions towards sustainability will be reflected in the White Paper in Component 1, and reviewed by the GPNM. Our Monitoring and Assessment approach is designed to address the need for international coordination in the reporting on nutrient impacts delivering directly to SDG Indicator 6.3.2. In doing so, the approach will be embedded across countries reporting to this indicator; 96 countries have reported to SDG 6.3.2 since 2017.

Potential for Scaling up. In most cases it is anticipated that the scaling-up will require incremental adaptation, sustaining the approaches promoted by the project more widely. The GEF and other donors have supported considerable research and supported measures to mitigate the impacts of nutrients over the last 20 ? 30 years. However, this project represents the first GEF supported collaborative activity to deliver a global direction on the sustainable management of phosphorus with a focus on addressing the degradation of lake ecosystems extending to coastal zones. The project outcomes are designed such that they extend beyond the life of the project into long-term income-generating initiatives, which are designed not to need incremental adaptation funding. The project?s engagement and dissemination activities (i.e., Component 1, 2, and 4) will raise public and policymaker awareness internationally of the benefits of effectively reducing phosphorus emissions to lakes, accelerating uptake at a global scale.

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[1] see: https://www.pbl.nl/en/publications/pclake-a-process-based-ecological-model-to-assess-the-trophic-state

[2] The major tributaries are the Min River, Tuo River, Chishui River, Jialing River, Wu River, Qing River, Xiang River, Han River and Gan River. The important lakes and reservoirs include the Dongting Lake, Poyang Lake, Cao Lake, Tai Lake, Dianchi Lake, Dan Jiang Kou and Er Hai Lake, etc.

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[7] https://www.asc-aqua.org/map/

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[6] Brownlie et al., ?Global Actions for a Sustainable Phosphorus Future.?

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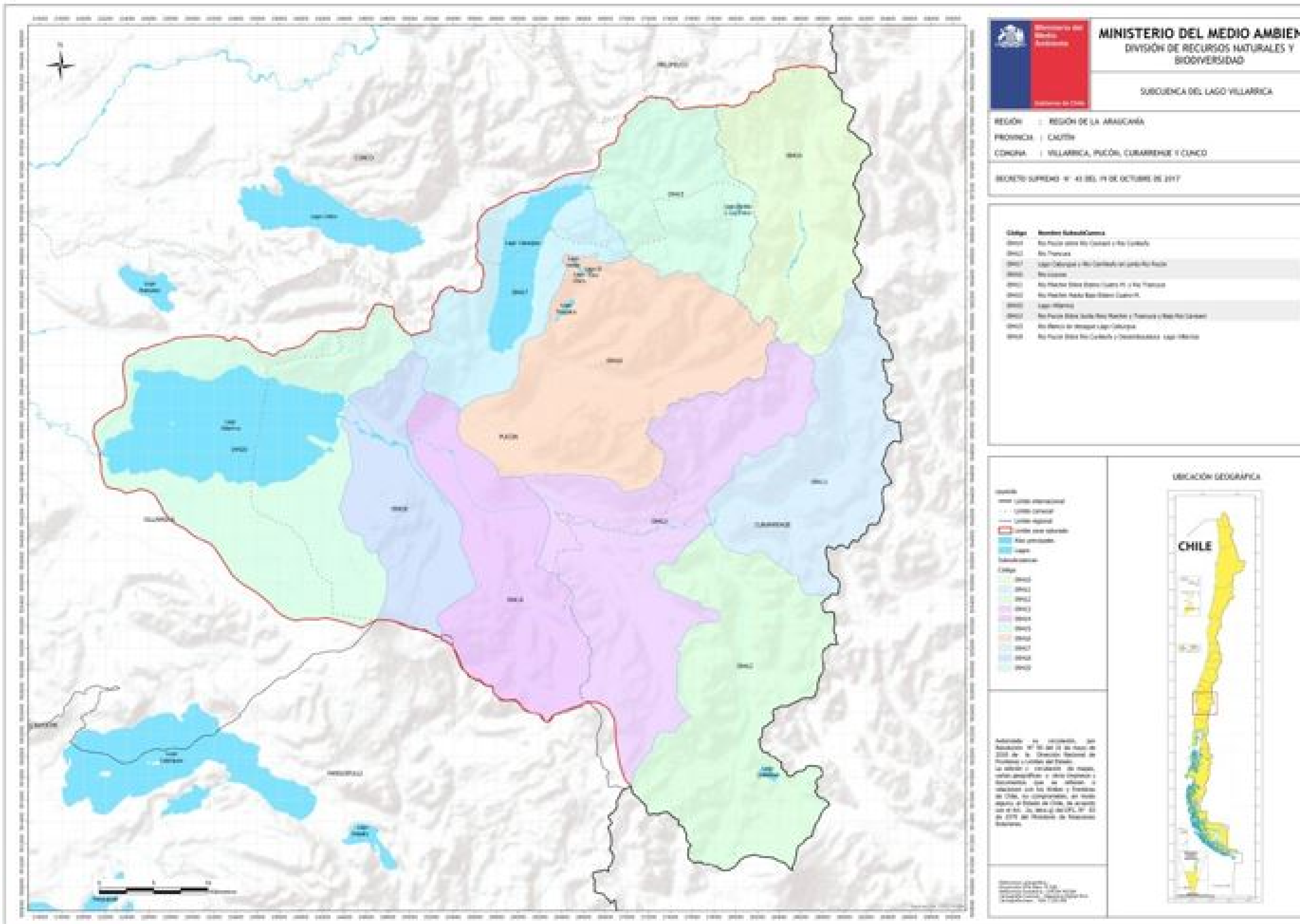
1b. Project Map and Coordinates

Please provide geo-referenced information and map where the project interventions will take place.

Map 1. Villarrica Lake Basin - 39.2585? S, 72.1179? W.



2. Stakeholders

Select the stakeholders that have participated in consultations during the project identification phase:

Indigenous Peoples and Local Communities Yes

Civil Society Organizations Yes

Private Sector Entities Yes

If none of the above, please explain why:

Discussions have been initiated with some partners listed in the table below, but not all. The list of stakeholders and their roles with respect to the project will be confirmed during the PPG.

Name of Organization	Summary overview and mandate	Role in PIF formulation and Possible Role in the Project
Regional/Global		
The World Bank	An international financial institution that provides loans and grants to the governments of low- and middle-income countries to pursue capital projects. It comprises two institutions: the International Bank for Reconstruction and Development (IBRD), and the International Development Association (IDA). The World Bank is a component of the World Bank Group. The work of the world bank is underpinned by three priorities which guide their work with countries i) end poverty and boost prosperity for the poorest people ii) help create sustainable economic growth, and iii) invest in people and build resilience to shocks and threats that can roll back decades of progress	The PIF development team worked with the World Bank in developing the PIF and they will be a key regional partner in particular in terms of government relations, and coordination of regional catchment management projects.
UNEP?s World Water Quality Alliance (WWQA)	An open community of practice, representing a voluntary and flexible global Expert, Practitioners and Policy Network, which advocates the central role of freshwater quality in achieving prosperity and sustainability. It explores and communicates water quality risks in global, regional, national and local contexts and points towards solutions for maintaining and restoring ecosystem and human health and wellbeing. It aims to serve countries throughout the lifetime of the 2030 Agenda for Sustainable Development and beyond. UNEP, and more specifically the Global Environment Monitoring Unit in the Science Division, acts as a Coordination Unit for the Alliance. The WWQA Ecosystem Work Stream led by a core group of UK CEH, IHE-Delft, World Bank Group, Wageningen University, UNEP, and JRC works directly with lake restoration practitioners to support the development of novel restoration programmes focusing on delivering socio-economic and environmental gains, especially in developing economies where data availability is sparse.	Coordination of Zero P Lakes Network; the project will also draw on the WWQA membership to contribute to Zero P Lakes Network. The WWQA will act as a conduit for strategic advocacy and cooperation at the global and regional levels to provide information and enhance capacities to design and implement effective management policies to address the growing problems of nutrient over?enrichment.

International Lake Environment Committee (ILEC)	A global coordination and knowledge exchange platform supporting the Integrated Lake Basin Management approach, working with UNEP and other relevant UN agencies and providing a conduit for knowledge exchange between lake basin catchment managers through their World Lakes Conference and joint activities of their voluntary Scientific Committee.	ILEC will be engaged through the WWQA in the course of discussions on collaborative links between the two bodies. We expect ILEC to play a role in identifying the Community of Practice in Component 2 and in developing the uP-Cycle Framework and Assessment Approach learning from experiences in the development of their Integrated Lake Basin Management Framework.
The Society for Ecological Restoration (SER)	A global network of over 4,000 members, fostering the exchange of knowledge and expertise among ecological restoration practitioners and scientists from diverse disciplines and backgrounds. In addition to communicating leading-edge tools, technologies and scientific findings, SER actively promotes best practices and effective restoration policy around the world.	SER will be an invited member of the Zero P Lakes Network, with contributions to the development of phosphorus emissions programmes. Raising awareness of the project to its membership.
The World Resources Institute (WRI)	A global non-profit organization that works with leaders in government, business and civil society to research, design, and carry out practical solutions to improve people?s lives and ensure nature can thrive, with expertise in policy, research, data analysis, economics, and political dynamics.	Consulted at PIF stage and contribution to Component 4, with expertise in communication strategies, data presentation and awareness-raising.

UNEP's Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities (GPA), and its Global Partnership on Nutrient Management (GPNM)	An intergovernmental mechanism to counter the issue of land-based pollution. GPA created three global multi-stakeholder partnerships. These are the Global Partnership on Nutrient Management (GPNM), The Global Partnership on Marine Litter (GPML and The Global Wastewater Initiative (GWI) (launched in 2013). The GPNM supports the GPA in addressing the challenge of nutrient excess or deficits and the potential negative impacts on the marine and terrestrial ecosystems, by sharing information globally and encouraging the adoption of improved nutrient management practices	Consulted at the PIF stage, the GPNM will act as a conduit for strategic advocacy and cooperation at the global and regional levels to provide information and enhance capacities to design and implement effective management policies to address the growing problems of nutrient over?enrichment
FAO?s Committee on Fisheries (COFI), and its sub-committee on Aquaculture	A subsidiary body of the FAO Council. COFI presently constitutes the only global inter-governmental forum where major international fisheries and aquaculture problems and issues are examined and recommendations addressed to governments, regional fishery bodies, NGOs, fishworkers, FAO and the international community, periodically on a worldwide basis. Its Sub-Committee on Aquaculture provides a forum for consultation and discussion on aquaculture and also advises on the preparation of technical reviews and issues and trends of international significance.	COFI will be an invited contributor to the Industry discussions in Component 1. Will provide technical expertise on measures to improve phosphorus management in aquaculture systems and informed narrative on opportunities at basin to global scales.
International Nitrogen Management System (INMS)	A four-year project funded by GEF (2017-2021) and implemented by UNEP. The GEF/UNEP-UK-CEH ?Towards the International Nitrogen Management System? project (INMS), is tasked with developing the evidence base to showcase the need for effective practices for global nitrogen management and to highlight options to maximize the multiple benefits of better nitrogen use.	Providing an advisory capacity for the PIF development team. In addition, providing access to evidence and tools with which to enhance our proposed Innovations Hub, including a measures database for sustainable nitrogen management which may also deliver on phosphorus sustainability

The European Sustainable Phosphorus Platform (ESPP)	A regional multi-stakeholder group, providing knowledge sharing, experience transfer and networking opportunities in the field of phosphorus management, facilitates discussion between the market, stakeholders and regulators, addresses regulatory obstacles, contributes to policy proposals, and contributes to defining a long-term vision for phosphorus sustainability in Europe. The Members of ESPP cover a wide range of actors across the whole value chain of phosphorus stewardship: phosphorus mining and processing, water and waste treatment, food, feed and agriculture, phosphorus reuse and recycling, innovation and technology providers, knowledge institutions, NGOs and governmental organizations.	Will be consulted on the development of the Innovation Hub, Component 4 and play a key role in raising awareness of the project to its membership.
The Our Phosphorus Future Network	A global network of academic, industry and government actors formed through their contributions to the OPF project. Their collective expertise represents a valuable knowledge resource to this project.	Contributions through the provision of expertise on phosphorus sustainability. Raising awareness of the project to its network.
Chile		
Chilean Environmental Ministry	The Chilean Environmental Ministry has the mission of leading the sustainable development of the country, through the creation of public policies and regulations, promoting good practices and improving citizen environmental education. Within its mandate, the ministry must analyse and systematise water quality measures; lead water quality and emission standards, and prevention and/or decontamination plans; consolidate environmental monitoring programs of aquatic ecosystems inside and outside protected areas. They collaborate with competent services in the elaboration of environmental policies for the sustainable use and management of water resources, among others.	The PIF development team worked with the Chilean Environmental Ministry in developing the PIF and they will be a key regional partner in Chile, in particular in terms of government relations, and coordination of regional catchment management projects.

Chilean Agricultural Ministry	The Chilean Agricultural Ministry oversees promoting, guiding and coordinating the forestry, livestock and agricultural activity of the country, with a mandate to advance competitive, sustainable, innovative and modern forestry and an agricultural sector, socially committed to regional and rural development.	The agricultural minister can help to assure the participation of the institutions under its mandate such as CONAF and INDAP. Through its institutions, this ministry could provide key information about forestation/reforestation plans, forest management, use of fertilisers, and implementation of more sustainable policies for the forestry, agricultural and livestock sectors.
Chilean Housing and urban planning Ministry (MINVU)	Government ministry in charge of developing policies for housing and urban issues. They also are in charge of developing municipal and inter-municipal territory use master plans. They also develop policies regarding the protection and management of riparian vegetation.	They can play a key role in developing urbanisation plans that consider lake protection, including, for example, riparian vegetation protection.
CONADI (National Commission for the Indigenous Development)	CONADI is responsible for promoting, coordinating and implementing the activities for the economic, social and cultural development of the indigenous people and communities; and to promote their participation in Chilean Society	The project includes within its stakeholder?s indigenous people, therefore CONDAI will be a key partner in terms of relations with these groups.
CONAF (National Forest Corporation)	CONAF is one of the institutions of the Agricultural Ministry. They are in charge of the administration of national forestry policies, encouraging the sustainable use of forest resources.	CONAF could provide key information about the native forest and exotic plantations registers. They could also work to provide more sustainable forestry management plans in the basin, considering, for example, the protection of the riparian vegetation.

INDAP (Agricultural Development Institute)	INDAP is one of the institutions of the Agricultural Ministry. They have institutional goals that are aligned with the project objective, such as promotion of organic agriculture, good agricultural practices related to sustainable development including recovery of degraded soils, among others	Share resources and expertise. There is a synergy between the project and INDAP goals, related to reducing phosphorus through the efficient use of fertilisers, development of organic agriculture, degraded soil recovery, among others. Contribute to the ICMG and the Zero P Lake Network.
Local Municipalities	Municipalities are the local governments in the Villarrica lake basin. They are responsible for promoting the sustainable development of their territories and protecting ecosystem services. They are also a key stakeholder in the education of awareness-raising of citizens to issues that impact the community.	Play a key role in providing local knowledge of the area, coordinating activities with the community and working with local actors to promote the sustainable management of soils, forests and wetlands.
SERNATUR	This is a public institution of the Ministry of Economy, Development and Tourism. They oversee developing policies related to tourism development, including the cultural, human, economic and environmental concerns in Chile. They have certifications for sustainable tourism and can elaborate and develop regulations to preserve the environment and its natural resources in touristic zones (ZOIT).	Promote the development of sustainable tourism and include good practices related to phosphorus management in sustainable tourism certifications. Contribute to the ICMG and the Zero P Lake Network.
SUBPESCA	This is a public institution of the Ministry of Economy, Development and Tourism. SUBPESCA is the institution that regulates fishing activities and aquaculture. They develop policies and regulations regarding fishing.	Contributions through the provision of expertise on aquaculture. Raising awareness of the project to its network.

SERNAPESCA	This is a public institution of the Ministry of Economy, Development and Tourism. SERNAPESCA They are in charge of supervising the compliance of fishing and aquaculture regulations. Their mandate is to contribute to the sustainability of the sector and the protection of hydrobiological resources and their environment	Contributions through the provision of expertise on aquaculture. Raising awareness of the project to its network. Contribute to the ICMG and the Zero P Lake Network.
SISS (Superintendence of Sanitary Services)	The government ministry responsible for enforcing laws related to sanitary companies, including potable water and wastewater uses. Among their attributions, they supervise the accomplishment of the emission standards from wastewaters treatment plants.	Play a key role in providing information related to the wastewater treatment plants, such as wastewater quality measures in the region. Provide information on the population connected and not connected to sanitation services within the catchment.
SMA (Superintendency of the environment)	The government ministry responsible for enforcing environmental law, including emission standards, environmental approval resolutions for projects, such as aquaculture projects, among others.	Play a key role in providing information on the accomplishment of environmental regulations of the industries in the basin, such as industrial wastes quality measures.
SSR (Rural Sanitary Services)	The government ministry responsible for ensuring an adequate supply of potable water and wastewater treatment in rural zones (created on November 20th, 2020).	Play a key role in the development of wastewater treatment systems that could reduce the phosphorus loads to the lake in the rural areas (noting the Villarrica Lake Basin has a high percentage rural population (around 40%))

DGA (General Water Directorate=	This institution is in charge of the regulation of the water rights and of the development of water quality monitoring such as the Villarrica Lake Water Quality program to comply with the water quality standard. Currently, the DGA has an online buoy measuring water quality parameters online in the Villarrica lake, such as chlorophyll ?a?, temperature, among others. They also have information related to precipitation, river flows and quality, among others.	Provide professionals related to water quality and its monitoring, and data on water quality, water quantity, precipitation, among others. Contribute to the ICMG and the Zero P Lake Network.
DIRECTEMAR (General Directorate of the Maritime Territory and Merchant Marine)	This institution is in charge of providing authorisation for performing constructions in the Chilean navigable lakes edge or to discharge wastewater into such lakes (e.g., Villarrica Lake). They also are in charge of taking samples of sediments and water quality for the observation monitoring network from the Villarrica Lake Secondary Water Quality Standard.	Play a key role in lake conservation since they authorise any construction in the lake edge, and also could provide sediment and water quality information. Contribute to the ICMG and the Zero P Lake Network.
Chilean Academic Institutions	Academic institutions play a key role in the knowledge of Villarrica Lake and its basin (including tributary rivers), especially the local institutions. A lot of Chilean Universities have been worked in Chilean Environmental Ministry projects and develop their studies located in Villarrica lake basins related to emission quantification (point and non-point sources), tributary river modelling, diffuse pollution models, water quality samples, among others. It is important to note that a Scientific Committee was created to support the elaboration of the Villarrica decontamination plan, which includes academics from local universities and non-local universities with projects in the area, including groundwater experts, limnologists, ecologists, among others.	Share resources and expertise. Academics can help to provide knowledge to better understand the behaviour of the lake and its basin, regarding the biological, physical and chemical processes. Contribute to the ICMG and the Zero P Lake Network.
Salmon Industries	According to the official draft of the Villarrica Decontamination Plan, the aquaculture sector provides around 38% of the total phosphorus load of the lake, being the most important anthropic pressure. A key stakeholder related to this sector is Salmonchile (and its technological institute, Intesal), which is a group of salmon companies including a lot of fish farms in the Villarrica Basin.	Salmon industries play a key role in the phosphorus emissions to the lake, they will be a key stakeholder to advance in the accomplishment of the Net Zero P framework.
Trade and Tourism Agroupations	There are two local Trade and Tourism Aggrupation?s (Camara de Comercio, Servicios y Turismo), Villarrica and Caburgua, that are non-profit Aggrupations formed by companies and unions related to the trade, services and tourism in the area.	They could play a key role in promoting the sustainable development of tourism in the area

Chilean Construction Association (?C?mara Chilena de la Construcci?n?)	A trade union formed by construction companies with a core aim to promote the development of the construction activity as part of the development of the country. They have headquarters in different Chilean regions including the Araucan?a region, where the local headquarter is located in Temuco	Construction activity plays a key role in the phosphorus management of the lake. The construction of properly wastewater plants in villages, and the protection of the riparian vegetation in housing projects, could help in the reduction of phosphorus emissions to the lake.
Aguas Araucan?a	Aguas Araucan?a is the sanitary company that is in charge of the Puc?n and Villarrica towns sanitary system that includes potable and wastewater services. They are the owner of the Pucon wastewater treatment plant (WWTP) (which discharge in a tributary of the river) and the Villarrica WWTP (which discharge downstream of the Villarrica lake).	A key stakeholder to advance in the accomplishment of the Net Zero P framework.
SOFO	The SOFO is an aggrupation of agricultural and livestock producers located in the Araucan?a Region, they are one of the main agricultural unions in Chile, which supports the development and strengthening of agriculture in the country.	They could be a key stakeholder to advance in the accomplishment of the Net Zero P framework, related to the sustainable use of fertilisers, the protection of the riparian vegetation and the development of organic agriculture.
Civil Society Organisations and Local groups	There are a lot of Civil Society Organisations in the basin and many are part of a committee created in the framework of the Villarrica Lake Decontamination Plan. This kind of organization in the area have knowledge about the phosphorus issues in the basin and could be aligned with the project objectives. Some organisations to mention are ONG Aguas Libres, Fundaci?n sustenta Puc?n, ONG Propuesta Ciudadana, Comit? Ambiental y de desarrollo comunal de Villarrica, Movimiento Ambiental Intercutlural Cuenca del Trancura, Fundaci?n Red Nuevas Ideas, amongst others.	Civil Society Organisations and Local Groups are active stakeholders in the basin. They have knowledge about the phosphorus issues in the basin and could support the project in terms of communication and diffusion of the project, including local demands in the project, among other topics. Contribute to the ICMG and the Zero P Lake Network.

In addition, provide indicative information on how stakeholders, including civil society and indigenous peoples, will be engaged in the project preparation, and their respective roles and means of engagement

See above section too with the table on stakeholder mapping which provides a tentative overview of project stakeholder engagement to be further refined during PPG.

Discussions have been initiated with some partners listed in the table above, but not all. The list of stakeholders and their roles with respect to the project will be confirmed during the PPG.

3. Gender Equality and Women's Empowerment

Briefly include below any gender dimensions relevant to the project, and any plans to address gender in project design (e.g. gender analysis).

The role women and men play in the value chains that drive the phosphorus cycle are different. Food value chains include agriculture and aquaculture sectors which are key to driving phosphorus cycles. Whilst there is limited high-quality sex-disaggregated data regarding value chains, it is acknowledged that gender equality in many of the key sectors involved in the food value chain has not yet been achieved.[1] For example, in agriculture, buyer-led horticultural chains typically exhibit strong gender segmentation by occupation, type of activity, and level of participation in the chain. The work of women is often arbitrarily assumed to be of lower value, and men typically occupy permanent and management positions.[2] In smallholder farming, women are typically concentrated as producers at the bottom of the chain and can find it difficult to take on more profitable roles as buyers, sellers, and processers for several reasons.[3] Similarly, in aquaculture, women are often not able to participate in aquaculture value chains in the same way as men, and benefits may not be evenly distributed between men and women.[4] Aquaculture is the fastest-growing food-producing sector in the world and generates significant employment opportunities at multiple scales. Developing gender-focused policies in agriculture and aquaculture will ensure higher production and productivity and generate a large number of social benefits. The fundamental premise is that paying attention to gender issues can increase production and productivity, speed up the adoption of innovations, raise household incomes, and ensure significant improvements to child health, nutrition, and educational levels [5], thus contributing to the achievement of the SDGs. Ensuring gender equality in the value chains driving global, regional, and national phosphorus cycles is an important step in achieving Inclusive Sustainable Phosphorus Economies. Gender equality must therefore be a central consideration when developing an internationally accepted framework and assessment approach to inform the development and implementation of sustainable phosphorus management programmes in lake catchments (as proposed in Component 2). The proposed project will investigate the use of gender-sensitive indicators in the framework to assess gender bias. It is also critical that actions to improve phosphorus sustainability at the global and regional scale can also contribute to gender equality.

As a step towards achieving a successful implementation model for gender equality, methodologies to assess gender equality within a sustainable phosphorus cycle will be included within the Framework produced by the proposed project (Component 2). During the PPG phase, the proposed project will investigate the availability of data on the role of women in the key activities identified, in particular in the pilot in Chile (Component 3) and across the Community of Practice (Component 2). This assessment will identify practical ways to increase women's engagement in, and returns from, value chains through addressing formal and informal barriers to women's control over assets, including shifting underlying gender norms and relations towards gender equality. A specific effort will be made to identify initiatives that enhance women's incomes and rights and to consider issues of marginalised gender factors. There is also a need to increase the effective participation of women in value chain organisations and in doing so enhance the potential of value chain development to become an agent of sustainable social change. The uP-Cycle project will embed such thinking into its Framework and strive for gender equality in its project coordination unit.

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[1] C.R. Farnworth, *Gender-Aware Value Chain Development* (UN Women In cooperation with FAO, IFAD and WFP, 2011), https://www.local2030.org/library/64/Gender-Aware-Value-Chain-Development.pdf; William J. Burke and T. S. Jayne, ?Disparate Access to Quality Land and Fertilizers Explain Malawi?s Gender Yield Gap,? *Food Policy* 100 (April 1, 2021): 102002, https://doi.org/10.1016/J.FOODPOL.2020.102002; Froukje Kruijssen, Cynthia L. McDougall, and Imke J.M. van Asseldonk, ?Gender and Aquaculture Value Chains: A Review of Key Issues and Implications for Research,? *Aquaculture* 493 (August 1, 2018): 328?37, https://doi.org/10.1016/J.AQUACULTURE.2017.12.038.

[2] Burke and Jayne, ?Disparate Access to Quality Land and Fertilizers Explain Malawi?s Gender Yield Gap?; Farnworth, *Gender-Aware Value Chain Development*.

[3] Farnworth, *Gender-Aware Value Chain Development*.

[4] Kruijssen, McDougall, and van Asseldonk, ?Gender and Aquaculture Value Chains: A Review of Key Issues and Implications for Research.?

[5] Farnworth, *Gender-Aware Value Chain Development*.

Does the project expect to include any gender-responsive measures to address gender gaps or promote gender equality and women empowerment? Yes

closing gender gaps in access to and control over natural resources; Yes

improving women's participation and decision-making; and/or Yes

generating socio-economic benefits or services for women. Yes

Will the project?s results framework or logical framework include gender-sensitive indicators?

Yes

4. Private sector engagement

Will there be private sector engagement in the project?

Yes

Please briefly explain the rationale behind your answer.

This project will convene a multi-stakeholder dialogue through activities at the global (Component 1 and 2) and national (Component 3) scales. Through stakeholder engagement workshops, we will develop new opportunities to address sector-specific emissions reductions at the lake basin to global scales, drawing on the influence and expertise of our global stakeholder community (i.e., the industry-representation of the GPNM and WWQA). The White Paper (O 1.1.3) will include a focus on private sector priorities for increasing the global sustainable phosphorus cycle which will guide national and basin-scale change across relevant sectors. We have engaged with key industries to provide an international perspectives in this context (e.g., Veolia and PhosAgro). The influence of this approach will be tested within Chile, for example, targeting improvements in aquaculture, agriculture, and nutrient recycling from wastewater, as outlined below.

Key private stakeholders related to phosphorus emissions to the lakes in Chile will be invited to engage in this project, such as Salmonchile (Aquaculture sector), Trade and Tourism Aggrupation?s (Tourism Sector), Chilean Construction Association (Construction Sector), Aguas Araucan?a (domestic Wastewater treatment sector) and SOFO (Agricultural sector). A more detailed description of these stakeholders is found in Section 8. The project will also engage with the key private sector industry associations through established partnerships, for example, the FAO?s Committee on Fisheries (COFI), and its sub-committee on Aquaculture, the GPNM and WWQA (e.g., connecting International Fertiliser Association and companies), as well as directly with innovation leaders operating globally to support nutrient recycling (e.g., Veolia and PhosAgro) and ecosystem restoration (e.g., Phoslock

Environmental Technologies). We will work to embed industry staff within activities throughout the components. For example, Phoslock Environmental Technologies have agreed to this model at PIF stage. These groups will be invited to participate in workshops and knowledge exchange activities to ensure the knowledge and viewpoints of the private sector are well represented in project outputs. These groups play a key role in influencing institutional policy changes to accelerate sustainable phosphorus use. The dialogue will focus on exploring the tremendous economic and financial values of sustainable phosphorus management, and how these values can be safeguarded or increased, through business practice changes and policies.

5. Risks to Achieving Project Objectives

Indicate risks, including climate change, potential social and environmental risks that might prevent the Project objectives from being achieved, and, if possible, propose measures that address these risks to be further developed during the Project design (table format acceptable)

The following main risks are identified for the project along with a risk mitigation strategy.

Risk	Rating	Mitigation Strategy
Failure to agree on common global approaches for indicators and models (C1)	Low	Development and utilization of inclusive networks of scientists and policymakers to ensure that demand for relevant information is met by the supply of appropriate data and indicators
Limited buy-in from global partners (C1-C4)	Low	Working with global key partners (which will contribute to the Zero P Lakes Network) include the International Lake Environment Committee (ILEC), UNEP?s World Water Quality Alliance (WWQA), The Society for Ecological Restoration (SER), The World Resources Institute (WRI) and UNEP's Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities (GPA) and FAO?s Committee on Fisheries (COFI), to facilitate the global dialogue on phosphorus.
A limited willingness by countries/stakeholders to develop strategies for problems of too much or too little phosphorus (C2-C4)	Medium	Close co-operation with countries and stakeholders across the phosphorus cycle will assist in identifying opportunities to mitigate phosphorus pollution. This will be facilitated by the Integrated Catchment Management Groups for each Pilot Lake Case and supported by the expertise of Zero P Lakes Network.
The impact of climate change and variability on conclusions	Medium	Specific attention to include effects of regional climate variation and global climate change will be examined and communicated in the context of uncertainty around the impacts of emissions reductions.

Inadequate communication between science assessment and policy development processes	Medium	Improved awareness and dialogue between researchers and policymakers through the development of the Zero P Lakes Network and Integrated Catchment Management Groups, which will specifically target the development of a process of science-policy support.
Lack of interest of private sector in activities related to reducing their phosphorus emissions due to the cost of the measures	Medium	Development of a private engagement strategy focused on the benefits of being part of the project to improve the image of the industry as a sustainable industry, for example, in the case of aquaculture in Villarrica Lake. Work with International Industry Bodies to communicate best practice guidance on more sustainable practices on the ground.
Lack of interest of the public organization to participate in the project	Medium	Develop an early engagement strategy informing the different public services during PPG phase of the project objectives.
Establish relationships with indigenous communities	High	Develop an early engagement strategy with CONADI, to achieve a correct approach to the indigenous communities and to assure their participation in the project.
Interactions with other stressors	Medium	The development of ?Future World? scenarios to set ambitions and identify priority actions will include assessing linkages with other global stressors interacting with phosphorus. Opportunities will be identified to optimize and future-proof existing plans for each Pilot Lake Case to enhance multiple benefits and ensure an adaptive management approach that considers multiple stressors (e.g., including climate change).
New valuation and decision tools, and sustainable finance mechanisms do not clearly show benefits to major partners (inter-governmental organizations, regional organizations, governments and private sector) to secure their participation in the interventions.	Low	Communications products and supporting analyses will be designed to make a compelling case for why these mechanisms are in the interests of these different constituencies to promote/adopt/design.
Natural disasters (e.g., hurricanes) affect the capacity of local communities to participate in intervention activities.	Low	Consultations with stakeholders and technical advisors to develop intervention activities that have greater potential for quick recovery after a natural disaster.

Effect of COVID-19 restrictions on project activities.	Medium	National and international travel was significantly affected by COVID restrictions. Given the future of international travel remains uncertain, the programme of work has been designed in such a way that it may be delivered remotely, with strong on-the-ground leadership teams in Chile and global partners who are well equipped to utilise virtual communications platforms should this be necessary. We expect a level of hybrid communication as the norm in the project.

COVID-19 Risk Analysis

Potential Risk	Mitigations and Plans
COVID-19 protocol measures and restrictions may limit travel and meeting opportunities.	? This is expected to be reduced over time as most countries have begun the roll-out of vaccinations. Assuming some time for the Project planning process, and then inception this risk may be greatly reduced for Project Implementation. During the PPG phase, online and Zoom interactions are not ideal but should suffice. CEH and UNEP will scale up their support as needed and the recruitment of local staff to support project formulation will be favoured.

Travel and social distancing restrictions	? The project development will benefit from the CEH, UNEP and countries combined skills for operating in virtual spaces, through Zoom and other platforms. ? Project preparation efforts can be a mix of virtual meetings, emails and calls. ? The CEH and UNEP?s regional offices will provide useful hubs for the outreach in each country to assist in national-level information, baseline research and regional coordination. ? For the private sector interactions, one-to-one socially distanced key meetings will likely take place as well as online meetings. As we progress with the MSP formulation and transition to project execution, face to face interactions are expected to be possible for what would therefore be the majority of the project execution time.
Changes in baseline and reduced co-financing sources caused by changes in government/project partner priorities due to delays until implementation.	? The PIF was formulated during the pandemic and the sources of funding had not demonstrated an effect from the health crisis. ? The Project Planning process will also consider the reality of the current status of baseline data for the project.
All potential partners (government, private sector and civil society) will have been affected by resource depletion (staff, funding, time) as a result of the pandemic and will be focused on recovery and rehabilitation in a post-covid scenario.	? The project will incorporate the need to consider post-COVID rebuilding considerations. ? The project will be assessing nature-based and/or post-covid recovery efforts.

COVID-19 Opportunity Analysis

The uP-Cycle project recognizes that the Covid Pandemic and related restrictions make it difficult to plan for a more sustainable future using communication approaches and monitoring systems that were relied upon up until only a few years ago. We identify opportunities provided to the project for increasing impact resulting from this challenge (Table below). The challenges of the Covid Pandemic relate also to our interaction with the environment, where international travel may be restricted, patterns of movement around the natural environment may change. Despite this, society remains dependent on a healthy natural environment. The uP-Cycle activities will provide security to such risks by producing virtual communication tools and outputs with which future recovery plans can be developed. We will work to develop incentives to improve agriculture, fishery, and forestry practices, through engagement with relevant government bodies in Chile (Component 3), and through discussions with International Bodies in Component 1 and the Global Community of Practice (Component 2) to identify opportunities to Build Back Better in a global context. These opportunities will be embedded within our project reports and briefing notes recognizing the critical role of phosphorus in food provision and water security, essential in our fight against the Covid virus. The impacts of the Covid Pandemic for phosphorus is already apparent. The World Bank report that we are amid a significant price spike for phosphate fertilisers, meaning that the price of food is likely to follow in the course of this project. This represents significant challenges for countries reliant on phosphorus fertilisers and represents a unique opportunity to drive reductions in emissions, reduce food waste, and increase recycling. To achieve this, we will focus discussions with stakeholders to identify opportunities to reduce environmental pressures associated with unsustainable phosphorus use to support more sustainable patterns of production and consumption. Through public awareness-raising in the Villarrica Basin, we will pilot a green cities approach designed to increase resilience in the context of sustainable phosphorus use.

Opportunity Category	**Project Plans**
Opportunity for new technology use and greater outreach.	? While travel is limited, stakeholder online access has been greatly enhanced. It is anticipated that the roll-out and requests for stakeholder consultations can reach a wider audience - unlimited by room size, or flight costs or limitations. ? Access to data and the need to design access and storage for gathering and collating information. Components 3 and 4 will ensure that this is incorporated into the project. ? Partners' and beneficiaries' more regular online access can lead to reproducible social media posts and articles with case studies can be produced/generated.

Climate Change Risk Screening

This Climate Change Risk Assessment follows the guidelines set out by the GEF STAP Guidance on Climate Risk Screening, June 4, 2019, GEF/STAP/C.56/Inf.03. We acknowledge that significant uncertainty exists on projections of the global extent of future climate change. We also acknowledge that climate change is expected to impact on freshwater and coastal ecosystems, and that the reduction of nutrient pollution may be an important adaptation measure to limit these effects.

With respect to the risk on the outcomes of the project it is important that we embed in our methodology a climate smart planning and projection approach. Our nutrient emission models will include the effects of RCP scenarios coupled with future nutrient loading scenarios to 2050, as requested by GEF STAP. This approach has been developed and applied previously by PBL and within the World Water Quality Alliance and will be downscaled for application in Chile. We expect that in accounting for the effects of climate change as outlined below, within future ecosystem restoration and sustainable phosphorus management plans we will ensure that the objectives of the project are met. We, therefore, assess the risk of non-delivery of project deliverables or outcomes as low and agree to develop a climate change risk screening log during PPG to track risk to project delivery.

We draw on authoritative reports on the effects of Climate Change on freshwater ecosystems as presented by the Intergovernmental Panel on Climate Change (IPCC, 2022; Fig F.1).

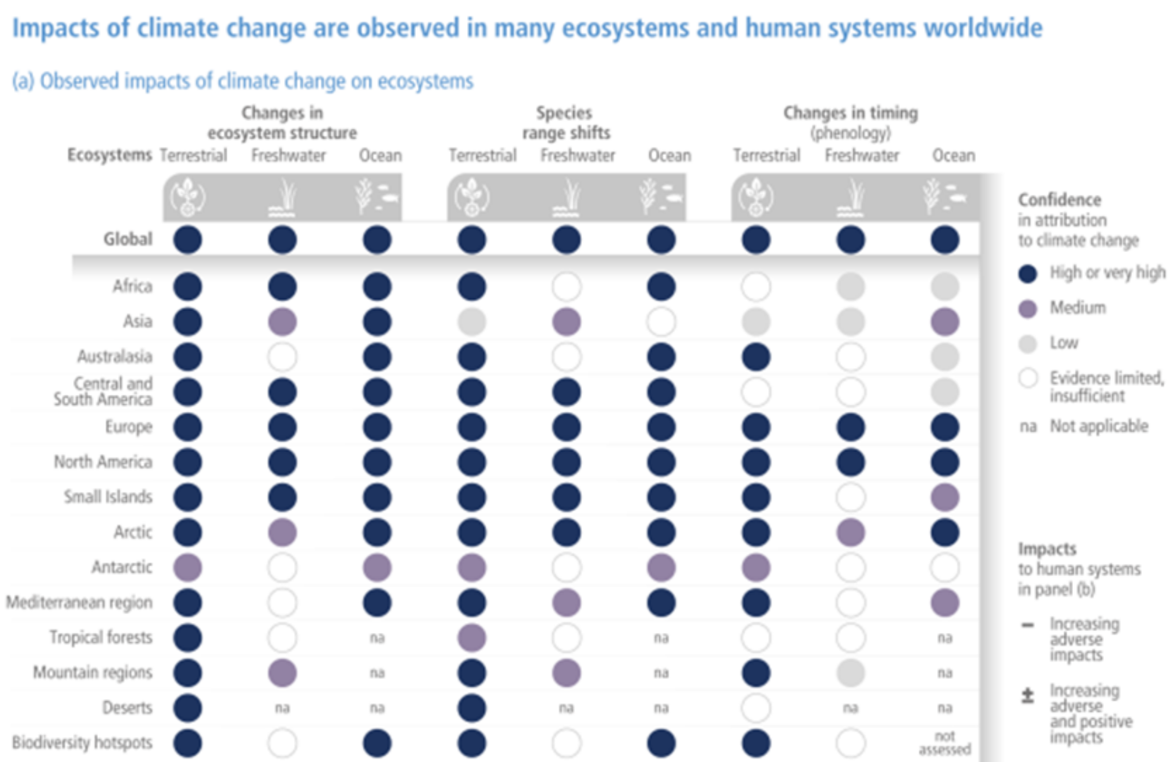


Figure F.1. IPCC (2022) assessment of the impacts of climate change on global terrestrial, freshwater, and coastal ecosystems:

https://report.ipcc.ch/ar6wg2/pdf/IPCC_AR6_WGII_SummaryForPolicymakers.pdf).

The Our Phosphorus Futures report (www.opfglobal.com; Chapter 5) presents a review of the literature on the global impacts of climate change on phosphorus loading and lake ecosystem responses as summarized in the following excerpts:

? The temperature of lakes, oceans and the atmosphere is rising, atmospheric concentrations of greenhouse gases have increased, snow and ice have diminished, and sea levels have risen. The spatial and seasonal distribution of fresh water will change under the pressures of a changing climate. Understanding how these changes will affect the quality and ecology of freshwater and coastal ecosystems at a global and regional scale is complex due to the variation in the geographical, hydrological, and climatic systems involved.

? Interactions between climate change effects on nutrient delivery and increased nutrient input to agricultural systems associated with intensification are unclear but are likely to exacerbate P pollution. We outline some of these complex interactions and their impacts on P delivery but stress that a comprehensive global-scale analysis of the effects of climate change on P delivery to freshwater and coastal ecosystems is beyond the scope of this chapter.

? An increase in atmospheric temperature may cause an increase in precipitation intensity and alter rainfall patterns regionally. An increase between 1.5 and 4.5 ?C in global temperature is predicted to increase global mean precipitation by 3 to 15%. Precipitation is expected to increase in higher latitude regions and some areas of the tropics and decrease in sub-tropical regions in the coming century, resulting in expected significant changes in rates of P transfer from land to water.

? Increased rainfall may have dual effects: in the short-term, it can reduce nutrient concentrations and algal blooms in lakes due to greater flushing of the system (shorter hydraulic residence time) but in the long-term, it can stimulate blooms due to increased nutrients associated with runoff. In arid and semiarid landscapes, a decrease in precipitation and an increase in the occurrence of droughts are expected. The drying of soils may increase P transport via erosion following heavy rain. Increased air temperatures in some regions will increase evapotranspiration and may cause a reduction in surface runoff.

? A decrease in surface water flow may reduce dilution of point source pollution in waters, so increasing nutrient concentrations, but may also reduce the mobility of soil-bound P, and thus reduce diffuse pollution to proximal waters. Increased rainfall will result in greater nutrient delivery to coastal zones, potentially enhancing eutrophication and hypoxia (i.e. low or depleted oxygen in a waterbody).

? An expected rise in sea level caused by anthropogenic warming may increase P inputs to coastal areas due to the exposure of more land for erosion, the loss of natural buffers such as wetlands and mangroves, and P mobilization through greater soil water saturation. The interactions between these drivers are complex and make predicting the overall impact of climate change on nutrient transport difficult.

The World Bank Group (2021) reviewed the country profile for potential climate change effects in Chile including key adaptation options for consideration. These are largely relevant here as evidence to support the processes outlined by the OPF report listed above. The following excerpts from the World Bank Country Profile for Chile are of relevance:

? Source: Climate Risk Profile: Chile (2021): The World Bank Group. https://climateknowledgeportal.worldbank.org/sites/default/files/2021-07/15916-WB_Chile%20Country%20Profile-WEB%20%281%29.pdf

? Climate change is expected to change water availability and seasonality as well as temperatures, which could also impact snowmelt and accumulation in the Andes. Changing temperatures are expected to have the highest impacts on the water systems in the Andean regions, especially in latitudes 30?40? and decrease in intensity from north to south.

? The majority of the population is concentrated in the center north while the southernmost areas of the country are sparsely populated, in large part due to historically challenging climatic conditions. Ensemble projection models estimate that annual severe drought likelihood for the country will increase by 34% by mid-century and by 63% by the end of the century.

? Some regions of the country are expected to experience desertification as the Atacama grows in surface area while other regions may experience scarcity. The areas between Coquimbo and O?Higgins are projected to see a 20%?25% decrease in precipitation by mid-century. Concurrently, the southern regions of the country may experience consistent or increased water availability on an annual basis with light decreases in spring and summer.

? The Chilean government estimates that precipitation in the Antiplano and regions of Arica and Parinacota could experience a 15%?25% increase in precipitation by the 2050s.

? Drought and water scarcity are projected to be concentrated in the central and northern regions compared to southern regions. Standardized Precipitation Evapotranspiration Index (SPEI) projections estimate that precipitation in Chile will be ?1.42 standard deviations from the historical mean by the 2050s. However, while projections estimate a decrease of ?1.41 standard deviations in Antofagasta in the North, the southernmost areas of the country, such as Punto Arenas are expected to see no change in mean annual drought. Chile is projected to experience significantly heightened dry conditions and significant drought severity, which will likely increase pressure on water resources for the country and region.

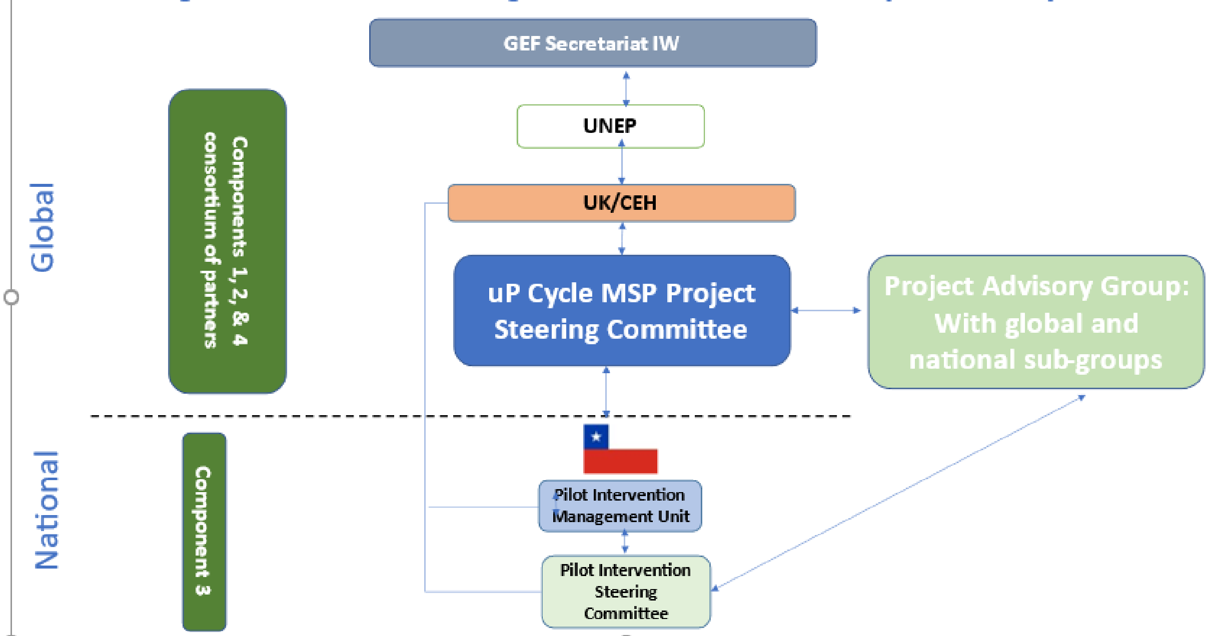
6. Coordination

Outline the institutional structure of the project including monitoring and evaluation coordination at the project level. Describe possible coordination with other relevant GEF-financed projects and other initiatives.

The proposed project will be implemented through UNEP. Its execution will be coordinated by UK-CEH. The on-the-ground activities will be executed through the Chilean Ministry of the Environment.

Coordination mechanisms. UNEP, UKCEH and the Chilean Ministry of the Environment will establish a Project Coordination Unit (PCU) for day to day project coordination, a Project Advisory Group (PAG) providing partners external advice to the project and whose composition will be further determined during PPG and, a Project Steering Committee (PSC) to steer the project execution. The PCU will coordinate day-to-day activities across all four Components and will report to the PSC. The PCU will be advised by a PSC meeting annually to ensure the delivery and quality of activities and outputs and to review budget. At the national level, a Pilot Intervention Management Unit will be established to coordinate the day-to-day national activities and liaise with the PCU. A pilot intervention Steering Committee will also be established and serve as Inter Ministerial Committee (IMC) to ensure multi-stakeholder engagement in the execution of the pilot intervention. At the Implementing Agency level, oversight and backstopping will be ensured through an appointed Task Manager within UNEP. The evaluation process, to be further outlined during PPG, will follow the monitoring and evaluation policy of both the GEF and the Implementing Agency.

Figure 1: Draft Tentative Organizational Structure of uP Cycle MSP Project



While the coordination mechanisms will be further developed during PPG, at the component level coordination is anticipated as follows.

Component 1 (Coordination Lead UKCEH). The World Resources Institute (WRI) and the PBL Netherlands Environmental Assessment Agency will develop with UKCEH the Global Phosphorus Emissions Dashboard. Component 1 will engage with the Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities (GPA) Global Partnership on Nutrient Management (GPNM) and other key global actors (e.g., FAO?s Committee on Fisheries, COFI) to facilitate engagement with international Industry Bodies and Innovation Platforms in Component 1, as well as the UN-Water SDG 6.3.2 Indicator Development Team. At PIF stage there is expressions of interest to the project from several global industry partners, including Phoslock Environmental Technologies, Veolia, and PhosAgro. The project will engage with other private sector stakeholders operating at global (i.e., through GPNM), national and transboundary (i.e., through the WWQA members) scales during PPG, in consultation with World Bank Group.

Component 2 (Coordination Lead UKCEH). Key partners for the development of the global Community of Practice activities include the World Water Quality Alliance (WWQA, including ILEC and World Bank Group), through which representatives of basin scale emissions reductions programmes will be identified and engaged. This community will be coordinated by the WWQA Ecosystems WorkStream. The University of Edinburgh and Link?ping University will coordinate the development of the uP-Cycle Framework and Monitoring and Assessment Approach and the preparation of the Global Baseline Report in consultation with World Bank Group.

Component 3 (Coordination Leads Chilean Ministry of the Environment/UKCEH/). The coordination team led by the Chilean Ministry of the Environment will engage with relevant government departments and non-governmental evidence providers in Chile during the PPG phase. UKCEH and the Chilean Ministry of the Environment will coordinate the data providers and the development of the surveillance and forecasting portal. Edinburgh University will support through its Overseas Office in Santiago, Chile, the stakeholder engagement workshops and will support the Chilean Ministry of the Environment in the preparation of the Transition Plan Report and awareness raising activities, the latter supported also by Link?ping University. The Chilean Ministry of the Environment will coordinate engagement through National Priorities (see Section 13) and with GEF- (see table below) and non-GEF national and bilateral initiatives relevant to the outputs of this component including the Lake Villarricca Decontamination Plan, relevant national policies relating to biodiversity and water quality management, reporting to the UN SDG Indicators, and input to the Humboldt Current Large Marine Ecosystem Strategic Action Programme.

Component 4 (Coordination Lead UKCEH). UKCEH will coordinate activities drawing on input across Components 1 to 3 to underpin output development. They will engage closely with the World Bank Group to ensure the widest and most relevant audiences are reached through the engagement activities. UNEP will help target engagement activities through UNEA. The uP-Cycle Innovation Hub will be coordinated and delivered by UKCEH, aligning with outputs of the GEF INMS project to enhance synergies.

Co-ordination with other GEF projects: The uP-Cycle Project will build upon and be closely coordinated with and complementary to other GEF-supported projects (see below).

Name of Project	**Potential opportunity for collaboration**
The GEF/UNEP-CEH ?Towards the International Nitrogen Management System? project (INMS) as mentioned in the baseline section is a four-year project (2017- ongoing) to develop the evidence base to showcase the need for effective practices for global nitrogen management and to highlight options to maximize the multiple benefits of better nitrogen use.	The proposed project will coordinate closely with the INMS team during PPG phase, given INMS is expected to conclude in 2022. We will build on the INMS outputs, outlined below, within the current project, supporting activities within the global nitrogen sustainability policy arena to build on the obvious synergies between phosphorus and nitrogen. We will build on evidence and tools with which to enhance our proposed Innovations Hub, including a measures database for sustainable nitrogen management which may also deliver on phosphorus sustainability.
Economic instruments and tools to support the conservation of biodiversity, the payment of ecosystem services and sustainable development (GEF ID 10213) GEF 7 - Project approved (2020)	Project Objective: Improve national financing of biodiversity through the design, implementation and optimization of market-based economic instruments (IECB) that reinforce public financing and facilitate the economic contribution of the private sector to maintaining Chile?s natural capital. The form of collaboration will be examined within the PPG phase of the project.
Restoration of biodiversity and ecosystem services at the landscape scale on productive agroforestry areas and their natural environment (GEF project ID 10718) GEF 7 - Concept approved (2020)	Project Objective: Restore productive and conserved landscapes in the Central zone of Chile. The proposed concept will coordinate with this project?s activities in component 2 promoting nature-based solutions and practices for sustainable agriculture. The form of collaboration will be examined within the PPG phase of the project.

Catalysing Implementation of a Strategic Action Programme for the Sustainable Management of Shared Living Marine Resources in the Humboldt Current System (HCS). GEF Project ID ? 9592	Implemented by UNDP and executed by IFOP, IMARPE, SUBPESCA, PRODUCE, MMA, MINAM, SERNAPESCA, SERNANP. 2017 ? ongoing. This project aims to facilitate ecosystem-based fisheries management (EBFM) and ecosystem restoration in the Humboldt current system for the sustainable and resilient delivery of goods and services from shared living marine resources, in accordance with the Strategic Action Programme (SAP) endorsed by Chile and Peru. The proposed project contributes to the SAP objective on ?*Improve the environmental quality of the coastal and marine ecosystems through integrated management, considering different pollution sources.?* The uP-Cycle project will engage with this project during PPG and highlight any additional contributions to achieving the SAP targets.

7. Consistency with National Priorities

Is the Project consistent with the National Strategies and plans or reports and assesments under relevant conventions?

Yes

If yes, which ones and how: NAPAs, NAPs, ASGM NAPs, MIAs, NBSAPs, NCs, TNAs, NCSAs, NIPs, PRSPs, NPFE, BURs, INDCs, etc

The project will contribute to:

The UN-Sustainable Development Goals

The project address multiple UN-Sustainable Development Goals (SDGs) as discussed below.

SDG 1 - No poverty & SDG 2 - Zero Hunger: through the development of sustainable phosphorus economies, the project provides opportunities for business growth providing sources of income. The project also contributes to risk reduction of sectors (and employees) reliant on healthy lake ecosystems. Through the protection and provision of livelihoods, the project also contributes to the reduction of malnutrition born through poverty.

SDG 3 ? Good Health and Well-Being: (Specifically Goal 3.9). By reducing the risk of harmful algal blooms, we will contribute to a reduction in illnesses from hazardous water pollution (e.g., cyanotoxins produced during harmful algal blooms).

SDG 5 ? Gender Equality: The project will implement and promote gender-balanced practices (see the section on gender equality above).

SDG 6 ? Clean Water and Sanitation: The project will reduce the risk to drinking water supplies through the improvement of water resources impacted by phosphorus pollution and the protection and restoration of water-related ecosystems. The focus of the project is on supporting and strengthening the participation of local communities in improving water and sanitation management. The project will support Chile in its reporting of nutrient emissions for lakes to SDG 6.3.2.

SDG 12 ? Responsible consumption and production: A central tenet of the project is to achieve more sustainable management and efficient use of natural phosphorus resources and to achieve the environmentally sound management of chemicals (e.g., fertilisers) and all wastes throughout their life cycle.

SDG 13 ? Climate Action: Through the action of phosphorus pollution, this project reduces the risk of algal blooms and their subsequent contributions to climate change through methane emissions.

SDG 14 ? Life Below Water: The project will contribute to the sustainable management and protection of marine and coastal ecosystems to avoid significant adverse impacts, including strengthening their resilience.

SDG 17 - Partnerships: The project will promote the development, transfer, dissemination and diffusion of environmentally sound technologies to all countries, through its outputs and the work of the Zero P Lakes Network. The project will also respect each country?s policy space and leadership to support the development of policies for sustainable development.

National Priorities in Chile

The project is consistent with the following national plan and policies in Chile.

The Water Code 1981 (reformed in 2005) includes the requirement for ?minimum ecological flows?. This was reinforced with the 2010 reform of Chile?s Environmental Law, Law 19,300, which regulates the protection of aquatic ecosystems through the implementation of ecological water flows.

Chile?s Law N? 19.300 of 1994, the Law N?20.417 of 2010 and the Law N? 20.600 of 2012 with reference to the water quality regulatory system. The basic regulatory water quality instruments are: (a) environmental water quality standards, (b) decontamination plans and strategies, (c) emission standards, and (d) environmental impact assessments for new investments.

Environmental regulation program 2020-2021. This program defines the sustainability criteria and the programmatic priorities regarding policies, plans and programs for the establishment of environmental and emission-quality standards, and other environmental management instruments. Within the prioritised plans and standards for the water component, the Ministry of the Environment includes the development and revision of several secondary water quality standards for rivers and lake basins in the south of Chile, that is expected to include phosphorus as a pollutant to be controlled, and the Villarrica Lake Decontamination Plan which is related to phosphorus as outlined above in the Chile Baseline. The revision of the groundwater; and the marine and continental waters emission standards will also be prioritised, and the influence of phosphorus for such standards as stated below.

Revision of the marine and continental waters emission standards (DS 90). The Ministry of the Environment is conducting a review of the emission standards for marine and continental waters. Within its changes published in the official draft. The Ministry of the Environment is proposing to change the maximum concentration allowed for total phosphorus in discharges into tributary rivers to a lake from 15 or 10 mg/L (depend on the river flows) to 2 mg/L.

Revision of the groundwater emission standards (DS 46). The Ministry of the Environment is conducting a review of the emission standards for marine and continental waters. Currently, The Ministry of the Environment is developing the official draft of this revision, and between its changes, is proposing to include a maximum concentration allowed for total phosphorus in discharges into groundwaters.

Villarrica Lake Secondary Water Quality Standards. The project is consistent with the Villarrica Lake Secondary Water Quality Standards which defines water quality levels for Villarrica Lake and includes parameters such as total and dissolved phosphorus and other trophic parameters such as transparency, oxygen saturation, dissolved nitrogen, total nitrogen and chlorophyll a.

Decontamination Plan for Villarrica (as outlined above in the Chile baseline).

Chile?s proposed long-term climate strategy. The project is consistent with the official draft of Chile?s long-term climate strategy. Within the Chilean?s long-term vision and its transition to sustainable and inclusive development to 2050, nature-based solutions play a key role as in this project. Reforestation and restoration are proposed in this long-term vision, along with other measures such as nutrient management and reduction of fertilisers used in agriculture, including tree planting in crops, restoration and protection of wetlands, use of specific nature-based solutions such as constructed wetlands, among others.

8. Knowledge Management

Outline the knowledge management approach for the Project, including, if any, plans for the Project to learn from other relevant Projects and initiatives, to assess and document in a user-friendly form, and share these experiences and expertise with relevant stakeholders.

The basin to international partnerships created in component 1 - 3 will facilitate knowledge exchange across sectors and countries. As outlined in Component 4, the project will produce annual update reports circulated to, for example, the WWQA and GPA; and through targeted activities around UNEA. The project will increase public awareness through targeted social media activities including through the GEF and UNEP social media outlets. Produced in collaboration with the GEF, UNEP, and UKCEH, we will deliver and disseminate a Policy Brief (Output 4.1.4) based on the more substantive White Paper (Output 1.1.3) highlighting the ecosystem restoration and economic cases for global action towards improved phosphorus sustainability governance. Importantly, the project's coordination activities will enhance capacity on the country level and dialogue among countries to support decision making and to identify bilateral/multilateral opportunities for action.

Knowledge products, data platforms, maps and communication materials generated by the project will be widely shared through the project website, which will be compliant with the IW: LEARN toolkit. Alongside the development of the Global Phosphorus Emissions Dashboard (see Component 1), the project will provide open access to resources on training, knowledge, and tools (e.g., the uP-Cycle Innovation Hub ? see Component 4) required by countries to develop and/or optimise their existing phosphorus emissions reductions programs within a common monitoring and assessment approach.

9. Environmental and Social Safeguard (ESS) Risks

Provide information on the identified environmental and social risks and potential impacts associated with the project/program based on your organization's ESS systems and procedures

Overall Project/Program Risk Classification*

PIF	CEO Endorsement/Approval	MTR	TE
Low			

Measures to address identified risks and impacts

Provide preliminary information on the types and levels of risk classifications/ratings of any identified environmental and social risks and potential impacts associated with the project (considering the GEF ESS Minimum Standards) and describe measures to address these risks during the project design.

Note the draft Climate Change Risk Screening

This Climate Change Risk Assessment follows the guidelines set out by the GEF STAP Guidance on Climate Risk Screening, June 4, 2019, GEF/STAP/C.56/Inf.03. We acknowledge that significant uncertainty exists on projections of the global extent of future climate change. We also acknowledge that climate change is expected to impact on freshwater and coastal ecosystems, and that the reduction of nutrient pollution may be an important adaptation measure to limit these effects.

With respect to the risk on the outcomes of the project it is important that we embed in our methodology a climate smart planning and projection approach. Our nutrient emission models will include the effects of RCP scenarios coupled with future nutrient loading scenarios to 2050, as requested by GEF STAP. This approach has been developed and applied previously by PBL and within the World Water Quality Alliance and will be downscaled for application in Chile. We expect that in accounting for the effects of climate change as outlined below, within future ecosystem restoration and sustainable phosphorus management plans we will ensure that the objectives of the project are met. We, therefore, assess the risk of non-delivery of project deliverables or outcomes as low and agree to develop a climate change risk screening log during PPG to track risk to project delivery.

We draw on authoritative reports on the effects of Climate Change on freshwater ecosystems as presented by the Intergovernmental Panel on Climate Change (IPCC, 2022; Fig F.1).

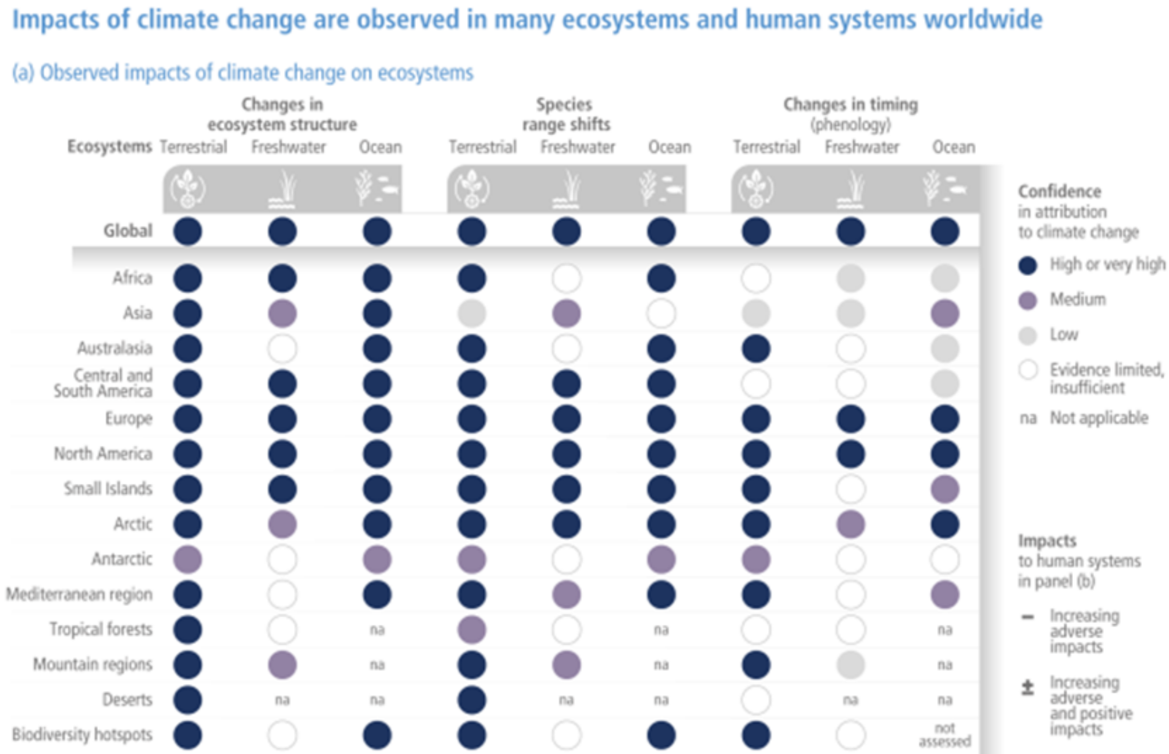


Figure F.1. IPCC (2022) assessment of the impacts of climate change on global terrestrial, freshwater, and coastal ecosystems:

https://report.ipcc.ch/ar6wg2/pdf/IPCC_AR6_WGII_SummaryForPolicymakers.pdf).

The Our Phosphorus Futures report (www.opfglobal.com; Chapter 5) presents a review of the literature on the global impacts of climate change on phosphorus loading and lake ecosystem responses as summarized in the following excerpts:

? The temperature of lakes, oceans and the atmosphere is rising, atmospheric concentrations of greenhouse gases have increased, snow and ice have diminished, and sea levels have risen. The spatial and seasonal distribution of fresh water will change under the pressures of a changing climate. Understanding how these changes will affect the quality and ecology of freshwater and coastal ecosystems at a global and regional scale is complex due to the variation in the geographical, hydrological, and climatic systems involved.

? Interactions between climate change effects on nutrient delivery and increased nutrient input to agricultural systems associated with intensification are unclear but are likely to exacerbate P pollution. We outline some of these complex interactions and their impacts on P delivery but stress that a comprehensive global-scale analysis of the effects of climate change on P delivery to freshwater and coastal ecosystems is beyond the scope of this chapter.

? An increase in atmospheric temperature may cause an increase in precipitation intensity and alter rainfall patterns regionally. An increase between 1.5 and 4.5 ?C in global temperature is predicted to increase global mean precipitation by 3 to 15%. Precipitation is expected to increase in higher latitude regions and some areas of the tropics and decrease in sub-tropical regions in the coming century, resulting in expected significant changes in rates of P transfer from land to water.

? Increased rainfall may have dual effects: in the short-term, it can reduce nutrient concentrations and algal blooms in lakes due to greater flushing of the system (shorter hydraulic residence time) but in the long-term, it can stimulate blooms due to increased nutrients associated with runoff. In arid and semiarid landscapes, a decrease in precipitation and an increase in the occurrence of droughts are expected. The drying of soils may increase P transport via erosion following heavy rain. Increased air temperatures in some regions will increase evapotranspiration and may cause a reduction in surface runoff.

? A decrease in surface water flow may reduce dilution of point source pollution in waters, so increasing nutrient concentrations, but may also reduce the mobility of soil-bound P, and thus reduce diffuse pollution to proximal waters. Increased rainfall will result in greater nutrient delivery to coastal zones, potentially enhancing eutrophication and hypoxia (i.e. low or depleted oxygen in a waterbody).

? An expected rise in sea level caused by anthropogenic warming may increase P inputs to coastal areas due to the exposure of more land for erosion, the loss of natural buffers such as wetlands and mangroves, and P mobilization through greater soil water saturation. The interactions between these drivers are complex and make predicting the overall impact of climate change on nutrient transport difficult.

The World Bank Group (2021) reviewed the country profile for potential climate change effects in Chile including key adaptation options for consideration. These are largely relevant here as evidence to support the processes outlined by the OPF report listed above. The following excerpts from the World Bank Country Profile for Chile are of relevance:

? Source: Climate Risk Profile: Chile (2021): The World Bank Group. https://climateknowledgeportal.worldbank.org/sites/default/files/2021-07/15916-WB_Chile%20Country%20Profile-WEB%20%281%29.pdf

? Climate change is expected to change water availability and seasonality as well as temperatures, which could also impact snowmelt and accumulation in the Andes. Changing temperatures are expected to have the highest impacts on the water systems in the Andean regions, especially in latitudes 30?40? and decrease in intensity from north to south.

? The majority of the population is concentrated in the center north while the southernmost areas of the country are sparsely populated, in large part due to historically challenging climatic conditions. Ensemble projection models estimate that annual severe drought likelihood for the country will increase by 34% by mid-century and by 63% by the end of the century.

? Some regions of the country are expected to experience desertification as the Atacama grows in surface area while other regions may experience scarcity. The areas between Coquimbo and O?Higgins are projected to see a 20%?25% decrease in precipitation by mid-century. Concurrently, the southern regions of the country may experience consistent or increased water availability on an annual basis with light decreases in spring and summer.

? The Chilean government estimates that precipitation in the Antiplano and regions of Arica and Parinacota could experience a 15%?25% increase in precipitation by the 2050s.

? Drought and water scarcity are projected to be concentrated in the central and northern regions compared to southern regions. Standardized Precipitation Evapotranspiration Index (SPEI) projections estimate that precipitation in Chile will be ?1.42 standard deviations from the historical mean by the 2050s. However, while projections estimate a decrease of ?1.41 standard deviations in Antofagasta in the North, the southernmost areas of the country, such as Punto Arenas are expected to see no change in mean annual drought. Chile is projected to experience significantly heightened dry conditions and significant drought severity, which will likely increase pressure on water resources for the country and region.

Supporting Documents

Upload available ESS supporting documents.

Title	Submitted
SRIF	

Part III: Approval/Endorsement By GEF Operational Focal Point(S) And GEF Agency(ies)

A. RECORD OF ENDORSEMENT OF GEF OPERATIONAL FOCAL POINT (S) ON BEHALF OF THE GOVERNMENT(S): (Please attach the Operational Focal Point endorsement letter with this template).

Name	Position	Ministry	Date
Miguel Stutzin S	GEF Operational Focal Point for Chile	Ministry of Environment	3/23/2022

ANNEX A: Project Map and Geographic Coordinates

Please provide geo-referenced information and map where the project intervention takes place

Map 1. Villarrica Lake Basin - 39.2585? S, 72.1179? W.