Climate Change Assessment Framework: An approach for assessing environmental risk in hydropower catchments

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Hydro Tasmania is Australia's largest generator of hydropower energy. Climate change projections predict increased variability and long-term drying in our catchments.
Hydro Tasmania manages 52 lakes, 33 rivers and numerous land parcels. Identification of how risks to our ecosystems will change as climate change intensifies requires a structured approach. We developed a climate change assessment framework to identify priority risks for mitigation and adaptation planning. The proposed approach assesses risk in two-stages:

- Stage 1 - Potential impact (unmitigated risk): identification of the scenario, assessment units, drivers and potential impacts (these will be ranked for each site using standard risk assessment systems).
- Stage 2 - Realised impact (mitigated risk): explores the ability to build resilience and adaptive capacity (i.e. reassess risk in consideration of potential adaptation actions to determine whether identified environmental risks can be effectively mitigated or reduced).

Application of the framework will result in the assessment of unmitigated (potential) and mitigated (realised) environmental climate change risk at various scales. It will enable the identification and prioritisation of adaptation strategies across multiple sites. It will also identify sites which may have a high risk but no practical adaptation or mitigation options.
The assessment will ensure a seamless integration of environmental climate change risks into existing business risk registers. The approach will ensure that risk is regularly reviewed to account for improvements in uncertainties or change in risk profile due to variation in knowledge or operations.
Uncertainties highlighted throughout the process will become the focus of monitoring and research.

Detecting regional trends in river flows whilst accounting for climate change

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Many aspects of river flow regimes are considered important for river flow management due to their influence on ecological, cultural or social values. River flow regimes are driven by climate conditions and local catchment characteristics. Climate conditions are important because they determine precipitation and evaporation. Catchment characteristics are important because they influence water fluxes, but these fluxes are also influenced by anthropogenic activities such as abstraction, damming, diversion, landcover change and drainage modification.

This work demonstrates a systematic approach to quantifying temporal changes in river flows associated with water management practices whilst accounting for temporal patterns in climatic conditions. Median seasonal flows were investigated as they relate to flow management and environmental flows. River flow time-series were obtained and matched to climate data for each catchment from NIWA's Virtual Climate Station Network (VCSN).

Statistical models were trained to predict river flows that would be expected given concomitant and antecedent weather conditions. Models were trained to data from an early period within each flow record, and therefore included the likely effects of any flow altering anthropogenic activities operating on-average over that period. Residual flow time-series were calculated by subtracting model predictions from observed values beyond the model training period. Residual flows represent deviation in observed flows away from those that would have been expected. Trend analyses were applied to quantify the confidence with which it can be stated that each flow time-series has been decreasing in absolute terms that include climatic influences, and whilst accounting for inter-annual changes in climatic conditions.

Undervalued biogeochemical and fire controls that down-regulate decomposition and alter carbon cycling in peatlands worldwide

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The primary mechanisms responsible for peatland formation in boreal regions are typically attributed to cool and uniformly wet soil conditions that limit microbial respiration. However, peatlands are widespread outside of boreal regions and continue to accrete carbon despite higher temperature, seasonal drying of root-zone soil strata and recurring patterns of wildfire. This implies additional regulatory mechanisms constrain rates of organic matter decomposition, and are often one of the primary controllers of carbon accretion and GHG fluxes in subtropical and tropical peatlands. Biogeochemical and biological mechanisms that down-regulate decomposition rates in peatlands to be discussed are: (1) higher production of polyphenolic and aromatic compounds in the litter of low-latitude shrub/tree communities than found in northern Sphagnum/Carex communities and (2) selective removal of labile carbon and buildup of recalcitrant pyogenic OM (hydrochar) produced by frequent low-intensity wildfires in the native-fire-adapted wetland communities, (3) dominance of slow-growing vs fast growing microbial populations and related decomposition rates. These often overlooked factors greatly influence carbon cycles in peatlands, which is relevant to global climate forcing and carbon budgets as climate-change alters peatlands worldwide.

Carbon conservation in an age of climate and land-use change

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Best practices of hydrologic management may be an important tool for carbon conservation in public lands, especially in future droughts predicted by the Intergovernmental Panel on Climate Change. In addition, increasing human demand is having a major impact on freshwater supply to inland and coastal wetlands. Hydrology is an important regulator of carbon stocks within publicly-managed wetlands, because of its direct relationship to primary production, decomposition and soil carbon. Therefore, hydrologic remediation by maintaining minimum flows during drought may be an important aspect of maintaining wetland carbon stocks in the future. Soil carbon stocks are regulated by hydrology through the balancing of processes including production and organic matter decomposition. Emerging research along the Mississippi (US) and Murray Rivers (Australia) suggest that even short periods of freshwater flow improve production. Similarly, mega-flooding events related to Hurricane Harvey and Irma freshened groundwater along the Gulf Coast of the United States. Precipitation and flooding gradients were negatively related to leaf and wood litter decomposition rate in the MRAV. Woody T. distichum detritus had a half-life of up to 300 years in the MRAV, which suggests the important role of wood in the maintenance of inland “teal” soil organic carbon. In the MRAV, soil organic carbon increased southward with increasing precipitation and air temperature (30-year climate normal). Other studies demonstrate that public lands harbor large amounts of carbon stocks across the US, suggesting that managers consider hydrologic remediation to maintain carbon stock in the future conservation of these wetlands.

Carbon cycling in the Supratidal Forested Wetlands of Australia: insights from understudied coastal ecosystems with significant restoration potential

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The supratidal zones of Australia's estuaries support ecosystems exhibiting a diversity of vegetation structures. Of these, Supratidal Forested Wetlands dominated by the genera Melaleuca and Casuarina (SFWs) have broad geographic distributions across tropical, sub-tropical and temperate coastlines. There is growing interest in understanding SFW ecosystem functions, vulnerability to climate change, and their potential for inclusion in coastal management strategies. The development of carbon trading mechanisms for Australian coastal wetlands may present a significant opportunity to redress historic losses (up to 75 to 90 % of pre-European extent in some catchments) of SFW to clearing, draining and flood mitigation works over the past two centuries.

We present new data showing carbon stocks and surface accumulation rates in SFWs are within the range of 'blue carbon' estimates in Australia and globally, and in many cases are higher than adjacent saltmarsh and/or mangrove. Through the use of a standardised litter bag experiment we show that organic matter preservation is higher in SFWs than in ecosystems situated lower in the tidal frame. Preliminary estimates also show soil-atmosphere fluxes of methane are negligible in the settings tested.

On the basis of water logger data collected across multiple sites, we propose that infrequent tidal inundation in the supratidal zone produces biogeochemical conditions similar to more widely recognised blue carbon ecosystems. Our research suggest SFWs should be considered within emerging coastal restoration initiatives and carbon accounting frameworks. Our findings also provide a foundation for future research into supratidal zone ecosystem function, in Australia and elsewhere.

Enhancing Carbon Storage in Mangrove Ecosystems of China through Sustained Restoration Actions

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Mangrove forests are facing the challenges of continual losses and unsustainable use globally. How to conserver and wise-use of mangrove forests are still hot issues nowadays. In this study, a scheme to transfer traditional shrimp ponds to mangrove wetland eco-farms and restore mangroves for carbon accumulation was developed. In Shijiao Station of Guangxi, the conversing of unused aquaculture ponds increased about 3.85 MgC a-1 (with 0.87 MgC a-1 of vegetative C and 2.98 MgC a-1 in soil) in the total 1.95 ha restored mangrove forests in underground aquaculture system of eco-farm. The net C stock change rates were 0.445 MgC ha-1 a-1 in vegetation and 1.53 MgC ha-1 a-1 in soil. The eco-farm in Shijiao Station has been run for 10 years, and the aquaculture products ranged 675 ~ 1 125 Kg ha-1 a-1. The running of this underground aquaculture would gain 92 ~ 154 million Kg aquaculture products if the one fourth of the unused ponds in south China recovered as the same scheme. Beside the multiple ecological roles as a health mangrove ecosystem, this approach can compensate local economy from land use change. Mangrove eco-farm in Guangxi of China provides a new and sustained approach to restore mangroves.

Hydrarch Succession Pattern of Coastal Wetlands in the Yellow River Delta area: implications for carbon sequestration.

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In the classical view of succession, deltaic wetlands are considered transient stages in the hydrarch development of a terrestrial climax community from offshore marine area. The important driving force for this hydrarch succession is brought about by rivers or externally caused environmental changes as opposed to the plant community itself. This study links a quantitative analysis of hydrarch succession to carbon sequestration in the Yellow River Delta area. Seven ~30-m-long cores were taken from this delta for sedimentary characteristics, lithology, mineral components, geochemistry, the benthic foraminiferal, ages determined by accelerator mass spectrometry (AMS) 14C, carbon concentrations and bulk density to document deltaic progradation process, which transforms from aquatic system (prodelta), shallow sea wetland (delta-front), tidal flat wetland to upper delta plain wetland. The results shows the hydrarch succession from prodelta-delta front to a climax terrestrial system could significantly alter the rates of carbon sequestration, which can be up to 1020.35 g C m−2 yr−1 for organic carbon, and 5202.24 g C m−2 yr−1 for inorganic carbon in the delta-front wetland, nearly 350 times and 640 times higher than those in the aquatic sediment (shelf deposit), respectively. The biggest contributor in the hydrarch successionally mediated differences of carbon sequestration rates is accretion rate, or the negative covariance between accretion rate and carbon concentration when accretion rate is lower than 1 cm/year. The implication is that human activities that affect delta progradation and hydrarch succession would profoundly affect the dynamics of carbon burial in coastal wetlands. Wise land/shoreline managements are therefore recommended.

Land Management Strategies Influence Soil Organic Carbon Stocks of Prairie Potholes

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The Prairie Pothole Region (PPR) is home to millions of wetlands nested in an agriculture–grassland matrix. Soil organic carbon (SOC) stocks in these wetlands are highly variable due to natural variation in biota, soils, climate (e.g., hydrology), and topography. Land-use history (cropland, grassland) and land-management practices (drainage, restoration) also affect SOC stocks. We conducted a region-wide assessment of wetland SOC stocks using data from the Canadian and U.S. portions of the PPR that cover a range of management types. Natural wetlands with no disturbance history had considerably greater SOC stocks than wetlands surrounded by cropland, especially those that were drained. Hydrologically restored wetlands did not show significantly greater SOC stocks than drained wetlands, and wetlands surrounded by restored grasslands did not show significantly greater SOC stocks than those surrounded by croplands, likely due to high variability attributable to several environmental factors within the region. We conclude that avoided loss of natural wetlands from drainage and avoided loss of native grasslands from cropping have the most benefit for preserving wetland SOC stocks. Robust PPR SOC models that incorporate multiple abiotic, biotic, and land-use factors are required to determine where and when restoration is most effective for SOC sequestration.

Paludiculture: wetland plant cultivation for carbon sinks, for the climate, and for the future

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Drainage of wetlands, especially those with peat soils, is one of the most climatically destructive of all human activities. Drainage oxidises peat and causes large greenhouse gas emissions; peatlands drained for agriculture are responsible for 30% of all global agricultural emissions, with rates of carbon emission that rival industrial sources. Restoring peat wetlands is therefore essential in combatting climate change, but this can be difficult to achieve given the demand and pressure to retain agricultural activities in landscapes with drained wetlands. Paludiculture – wet agriculture and forestry on rewetted peatlands – allows continued biomass production with reduced emissions and other environmental benefits such as nutrient removal. We have been comparing wetland macrophytes for their suitability for paludiculture, using their photosynthesis-leaf nitrogen responses to compare preferences over the range of nutrient availability found in drained agricultural peat. For maximum nutrient removal, Typha species have superior responses to N, with a photosynthesis-N slope of 10.4 µmolCO2 g-1N s-1 in European Typha latifolia, vs. 6.5 µmolCO2 g-1N s-1 in the standard bioenergy crop Arundo donax. New Zealand raupo (T. orientalis) is even more responsive, with a slope of 12.1 µmolCO2 g-1N s-1. These findings have coincided with increased interest in Typha as a biofuel feedstock and construction material, suggesting that paludiculture could provide unique environmental and commercial benefits for wetland restoration. New Zealand harakeke (Phormium tenax), with a photosynthesis-N slope of 7.2 µmolCO2 g-1N s-1, is also highly suitable for paludiculture that can compete with normal agriculture.

Exploring the immense value of community volunteer involvement in wetland restoration works

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Nature Glenelg Trust has now engaged community volunteer help in wetland restoration works at many sites in south-eastern Australia on public and private land. Beyond the obvious practical assistance provided for the construction of geo-fabric sandbag weirs, which was our main initial intention, we have since discovered and observed a range of other benefits and incidental spin-offs as a result of this approach to wetland restoration – for both the participants and the communities they represent. This presentation will explore a range of situations where volunteers have assisted Nature Glenelg Trust with wetland restoration works in Victoria and South Australia, and examine the ecological and sociological outcomes of this hands-on and inclusive approach to wetland restoration project delivery.

Incorporating Indigenous Research Methodologies into Wetlands Management

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Indigenous Research Methodologies for considering cultural values of wetlands is a missing component in wetlands management in Australia. On this dry, flat and ancient continent Traditional Ecological Knowledge has been passed on from generation to generation for millennia. This is a profound reliance of knowledge of surface and groundwater, has been critical to ensure the survival of Indigenous peoples in a dry landscape, through the role of traditional knowledge in finding and protecting water places. Indigenous Research Methodologies can provide a basis for the exploration of this knowledge in a way that that is culturally appropriate, and which generates a cultural safe space with Indigenous researchers and communities. This aims to shift the research paradigm away from Indigenous peoples being the researched under non-Indigenous research methodologies to becoming the researchers. Indigenous Research Methodologies are rooted in Indigenous epistemologies and ontologies and represent a radical departure from more positivist forms of research (Wilson 2001). This allows the Indigenous researcher to derive the terms, questions and priorities of what is being researched, how the community is engaged, and how the research is delivered.

Traditional knowledge meets drones and spatial imagery to improve wetland management

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One of the most critical and challenging aspects of wetlands management is understanding the natural and anthropogenic changes in water inundation. Spatial imagery is a powerful tool to assess long-term and continuous information on changes in surface water. However, spatial imagery has limited capacity to differentiate among open water, wet soils, and water covered with aquatic vegetation. We developed a methodology with the help of drones in different wetland types across Australia that combines field and spatial modelling to differentiate among these confounding signals. The tool was supported by the knowledge of Traditional Owners who understand the long-term changes and values of the wetlands within their country. As a result, we create a powerful tool to monitor, conserve, and best manage the valuable cultural and ecological services that wetlands provide.

Citizen science to investigate and reduce plastic pollution in river catchments

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Single use plastics are a major concern for the public, regulatory and business worlds. In recent decades, people's excessive reliance on single use plastics has contributed to widespread impacts on terrestrial, freshwater, and marine ecosystems across the globe.
I will summarise findings from various ongoing studies using novel methods to monitor and manage plastic use and resulting pollution. Through an in-depth review of recent studies, we identified the "top ten" single use plastic items that are present in European freshwater ecosystems and evaluated the most impactful actions that consumers can take to reduce their contribution to macroplastic pollution. We also developed an online plastic footprint calculator of people's use of plastic items on-the-go and identified blockers to a more sustainable plastics use. Finally, we developed a series of citizen science methods to determine the sources and sinks of macroplastic pollution in river catchments. To reduce plastic pollution in freshwater ecosystems, findings from these projects will be used to increase people's awareness and improve decision making from the personal and community levels to the catchment governance level.

Engaging K-12 classrooms and community partners to test the effects of saltwater intrusion on organic matter processing in coastal wetlands

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Citizen and participatory science are important for creating collaborations across academic institutions, NGOs, and government agencies to inform and promote the wise use of wetlands. The FCE LTeaER project is modeled after the Tea Bag Index study and is used to engage participants in a long-term decomposition study examining the drivers of organic matter (OM) transformation in the Florida Coastal Everglades (FCE). In this study, we quantified breakdown rates of fast (green tea) and slow (red tea) decomposing OM in two major drainage basins of the FCE. We compared breakdown rates in the deeper, peat-dominated, higher phosphorus Shark River Slough (SRS) wetlands with the shallower, marl-dominated, lower phosphorus wetlands of Taylor Slough/Panhandle (TS/Ph). Green and red tea were deployed in both SRS and TS/Ph, retrieved after two and ten months, and used to calculate percent mass loss. After two months, mass loss was consistently higher in green tea and freshwater marshes. After ten months, mass loss was higher in mangrove sites of SRS and freshwater marshes of TS/Ph. Our results suggest that both saltwater intrusion and shallower water depths can increase OM breakdown in highly nutrient limited coastal wetlands. Higher OM mass loss in shallower freshwater marshes could be driven by higher temperatures, and OM mass loss is higher in mangroves with higher nutrient availability. These results are being used for: professional development; student, teacher and undergraduate presentations; and by researchers to generate new questions about how saltwater intrusion differentially affects OM processing along freshwater-to-marine gradients in coastal wetlands.

Living Bung Yarnda - Developing an environmental stewardship program for Lake Tyers, East Gippsland

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Bung Yarnda (Lake Tyers) is a drowned river ICOLL on Krauatungalung country in East Gippsland, part of the Ramsar-listed Gippsland Lakes. The fires of 2019-20 lapped around the margins of the catchment, so the lake and its surrounding forest has become a refuge for local wildlife. The area is home to the Lake Tyers Aboriginal Trust and site of the former mission, a large artistic community and passionate recreational fishers. Lake Tyers is also a place that tourists visit year round. All of these communities are connected by their love for this beautiful corner of the world.

We have developed a multi-proxy monitoring program for Bung Yarnda (Lake Tyers) and its catchment to record the observations that people are passionate about: a community science program that incorporates community expertise, local knowledge and science. This includes regular monitoring of birds, fish, water quality, vegetation and aquatic invertebrate communities, as well as artists drawing, writing about and painting the vistas around them and visitors' photopoint snaps. It also captures people's lived experience and knowledge of place. The data gathered will be integrated into a geospatial database, which we can use to track change over time and also data-mine to answer questions of concern. The project aims to develop a community-led environmental stewardship plan to improve the health of the lake and surrounds, increase awareness around threats, and deepen environmental connections to this majestic place – for locals and visitors alike.

Pros and Cons of citizen science, how to make the best use of a participative approach

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Ramsar signatory governments formally report on wetlands every three years. However, Ramsar Information Sheets (RIS) are largely out of date, and government officials are often not in close touch with wetlands. A 2014 WWN survey of civil society groups found that relations between local groups and government focal points was not very positive, and that governments are often not sufficiently resourced or focussed on wetland protection.
The World Wetland Network (WWN) was set up formally at Ramsar COP10 (2008) and has an active committee of seven NGO representatives from across the world, with 200 active members. WWN plays an active role at COPs, supporting and coordinating NGO/CSO input to discussions on resolutions and promoting the role of civil society through side events and informal networking with contracting parties. WWN also encourages citizen science approaches to support wetland monitoring such as the Global Citizen Science Survey on Wetlands completed with SWS and WWT.
Local people know their wetlands best and often take practical action to improve the state of their wetlands. Citizen science activities can link community wetland knowledge to government reporting and decision making. This paper will present examples from WWN members to demonstrate how local CSOs work to protect their wetlands and raise awareness amongst local people.

Using Citizen Science to Assess Status of Waterbirds in India

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Initiated in 1987 the Asian Waterbird Census is the longest running citizen-science programme providing information on status of waterbirds and wetlands. Jointly coordinated by Wetlands International South Asia and Bombay Natural History Society in India, the census has resulted in an extensive record on status and trends in waterbirds. During 2006-2015, over 1400 volunteers conducted waterbird counts at 1409 wetlands of 23 States and 3 Union Territories. The Census recorded presence of 170 waterbird species (85% of total waterbird species in India), including 142 migratory species (84% of total migratory waterbird species in the country) from 1409 wetlands (0.18% of the total number of wetlands in the country). Two hundred seventy-two wetlands were noted to support 1% or more of the bio-geographic population of at least one species of waterbird and qualify as Wetlands of International Importance under criterion 6 of Ramsar Convention. Sixty-five wetlands supported 20,000 or more waterbirds during at least one year of the assessment period. In five Ramsar sites which were counted at least five times during 2006-2015, the population of Cranes, Gulls, Terns and Skimmers reported a declining trend. The population of one in every four waterbird species recorded in the census, for which trends in the Central Asian Flyway are known, is declining. Reviews of population estimates and population trends of waterbirds, especially migratory waterbirds using the Central Asian Flyway, needs urgent attention as this information is outdated or is of poor quality.

Using Indigenous and local community knowledge for wetland monitoring, management and decision making in Guyana, South America

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Indigenous and local community approaches to management and decision making can result in effective biodiversity conservation and the maintenance of important natural resource benefits. The integration of this knowledge within wider decision making requires novel approaches. The Community Owned Solutions approach was developed with Indigenous communities in the Guiana Shield region of South America but has been adapted to be used to engage communities around the world. The approach helps create an environment of mutual respect that can make stakeholder engagement and knowledge sharing more effective. It empowers the community to take control of how they wish their community to develop and face up to current and emerging challenges. This approach identifies and shares solutions to sustainability challenges such as climate change adaptation, biodiversity loss, natural resources depletion, lack of governance, health emergencies and cultural loss. The identification of these solutions allows communities to share best practice in how to monitor and manage their natural resources. The approach is fundamentally transdisciplinary and holistic, and has been used by people working in the fields of development, nature conservation, health, natural resource management, social welfare and education. This paper demonstrates, through case studies related to natural resources, protected area and mental health management, how the core approaches of a system viability assessment and participatory visual methods build capacity in monitoring and management strategies empowering communities to actively share and communicate their issues, experience and knowledge with other communities, governments and policy makers helping contribute to more effective decision making.

Wetland citizen science: Hard facts or fake news?

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Citizen science is increasingly recognised as a valuable approach to improve the knowledge and understanding required for robust environmental management. We report on the results of a citizen science survey conducted on the status and trends of over 500 wetlands from across the globe. Whilst many wetlands were reported as being in fair or good ecological character state, many (particularly those already in a poor state) were reported as deteriorating. Although designated Ramsar Sites were reported as currently having a slightly better state than other wetlands, widespread deterioration of Ramsar Sites as well as other wetlands was reported. Significant regional differences were reported on the state of wetlands and their extent of improvement or deterioration. Large wetlands, particularly in Africa but also in Latin America and the Caribbean, were reported to be in a worse, and increasingly deteriorating, state than smaller wetlands in North America, Europe and Oceania. Numerous drivers are contributing to degradation and loss of wetlands. However, our data suggest that positive outcomes can be delivered where local community awareness, implementation of conservation measures, cultural values/traditions, tourism and forestry are proactively integrated in order to achieve the wise use of wetlands. Future plans to replicate and expand the citizen science survey approach will also be discussed.

Wise Development: Approaching Wetland Through Community Participation

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Western Ghats, the biodiversity hotspot of the world, witness a very unique flora and fauna that flourishes in basalt dominated lithology. The basalt being largely nonporous leads to formation of a variety of terrestrial and coastal wetlands, vital in providing water to the erstwhile biodiversity even in dry seasons. The five districts of the state of Maharashtra known as Kokan are integral part of the Sahyadri Ghat biodiversity reserve. The Wetland Brief Documentation Committees (WBDC) formed in all these districts by the district collectors on the instructions of honourable High Court, Mumbai are the best efforts of community participation the wetland brief documentation work by the voluntary services provided by the experts.

The wetland brief documentation emerged with the research methodology that involved people's science approach, barefoot botanists, use of Open Data Kit application, marking HFL line, no development buffer zone and habitat mapping. In the two tehsils of Raigad District, Karjat and Khalapur, a geographical database was created by using several inputs like maps, satellite images and photographs to emerge with comparative analysis and change detection. Community participation by merging the local knowledge with the advance technology to promote wise development has been initiated. It also aimed at encouraging and training various communities and local administrative bodies to participate actively in managing their own natural ecosystems, developing green infrastructure in urban and rural landscape for maintaining sustainability through wetland preservation.

The proposed research paper aims at discussing the model focusing on community-centric pattern of wise development of wetlands.

Consequences of hydrological alteration for beta diversity of fish assemblages at multiple spatial scales

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Effects of dam operation and extraction of water from rivers on spatial variation in hydrological regimes, and consequences for freshwater biodiversity, are widely predicted but seldom assessed empirically. Evidence of linkages between hydrology and beta diversity contributes to water-management decisions to support landscape-scale biodiversity and avoid inadvertently contributing to further biodiversity decline. Using six lowland rivers that formed a gradient of hydrological alteration, we examined (1) spatial variation in hydrology under modelled scenarios of low water-resource development and flow modification by dams and extraction, (2) how beta diversity of fish among and within rivers was associated with spatial hydrological variation, (3) whether patterns of overall beta diversity differed between native and non-native species, and (4) the associations of spatial and environmental variables and both recent and long-term hydrology with beta diversity. Spatial variation in hydrology among rivers was higher under the modified scenario than under the low-development scenario yet change in the magnitude of within-river (longitudinal) variation was inconsistent between rivers. Beta diversity among rivers was significantly associated with spatial variation in hydrology only in certain circumstances (native species assemblages in specific years). Within-river beta diversity varied among rivers yet was unrelated to longitudinal variation in modified hydrological regimes. Patterns of beta diversity did not differ appreciably if non-native species were included or excluded in analyses. These findings fail to support predictions adopted in ecohydrological science that water resource development homogenises hydrological regimes, in turn causing biotic homogenisation in lowland rivers.

Development of downstream passage options for shortfinned eels; the Trevallyn dam downstream eel bypass project

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There is a significant body of evidence that global stocks of freshwater eel (family Anguillidae) are in decline, and it is likely that the vulnerability of anguillid eels to anthropogenic disturbances is compounded by their often arduous migration requirements.
While short finned eels (Anguilla australis) are adept at negotiating a wide range of natural instream barriers, large dams and weirs impact upon both upstream and downstream migration. Trevallyn dam is located in the downstream reaches of Tasmania's largest water catchment, and blocks the migratory path of eels between the Tamar estuary and the South Esk River. Upstream migration of juvenile eels past the dam is facilitated via an elver ladder and a trap and transfer program, however the dam spills infrequently and downstream migrating eels have little option but to pass through Trevallyn power station to reach the estuary.
Hydro Tasmania conducted a range of studies to understand the migration behaviour of eels around the power station intake. The results of these studies informed the design of a downstream eel bypass for Trevallyn dam. Construction of the bypass commenced in February 2020 and was completed in April 2020. Wet commissioning was conducted in April 2020 to trial the bypass performance monitoring program that will be run during the 2020-2021 migration season. A range of approaches were used, including downstream netting, the deployment of Sensorfish to quantify passage hydrological characteristics, and the use of Adaptive Resolution Imaging Sonar and underwater video to observe eel behaviour in and around the bypass entry.

Ecosystem condition monitoring in temporary rivers in Queensland, Australia... with ants, plants, and fish!

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Many Queensland rivers and streams stop flowing and dry up, causing havoc for river health assessments that rely on traditional 'wet phase' indicators. We developed an approach that incorporates all phases of temporary rivers, be they wet or dry. The focus is on characterising the dominant threats to river health in an assessment region. Threats are ranked based on expert elicitation and then cause-effect conceptual models are used to select indicators representing the greatest threats and responses of the ecosystem to them. For example, in temporary rivers of the Queensland Murray-Darling Basin, we quantified the threat posed by feral pigs to dry riverbeds using pig damage intensity and used terrestrial invertebrate metrics to measure ecosystem responses to the threat. For wet locations we used the number of exotic fish species to characterise the intensity of the threat they posed and the proportional biomass of exotic to native fish as the ecosystem response metric. Indicators like riparian vegetation condition are relevant across all hydrological phases. Because indicators relate to specific threats they identify those most critical, and allow specific recommendations for management to improve temporary river health across their flow phases.

Fishing the deep web- illegal trade in an unregulated industry

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With significant volumes of non–native freshwater fish transported globally for ornamental trade, effective biosecurity management and compliance measures are critical. Active management, as opposed to traditional passive management currently routine in Australia, is vital for protecting sensitive aquatic ecosystems. However, this is unachievable without a sound understanding of species already present and traded within borders. The scant previous research available cannot guide the future management of this unregulated industry. Instead, direct surveys of species in trade are needed to create an accurate list of the ornamental community. Online monitoring has become a large part of ornamental research internationally, aiding in understanding the non-native species traded, where potential incursions may occur, and has allowed for the compilation of a trade list. Compiling this list is an important first step towards risk assessing the invasive potential of traded species, narrowing the potential pool of species to assess from thousands to several hundred.

As part of my PhD research, we monitored aquarium stores and ornamental hobbyist groups trading freshwater fish in Queensland. A considerable ornamental community emerged, involving thousands of participants advertising and transporting hundreds of species all around Queensland, including highly invasive and restricted fish. In my presentation I will shine a light on the deep web and the biosecurity threat this prosperous and prolific community poses to our freshwater ecosystems if it remains unmanaged and unchanged.

Hydrogeomorphic character = landscape heterogeneity…but do the fish care?!

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It is challenging to determine the combined influence of hydrology and geomorphology on fish community dynamics, particularly when considering their interaction at multiple spatial and temporal scales. Several hydrogeomorphic variables representing two spatial (10s m to 10s km) and two temporal (inter-annual to decadal) scales have been identified as contributing to spatio-temporal heterogeneity of the Upper Mississippi River System (UMRS) floodplain. This study aims to test if these same variables explain variation in fish community structure among eighteen backwater and island lake habitats representing gradients of hydrological connectivity and ecosystem size.
Preliminary results suggest that many of the hydrogeomorphic variables contributing to the spatio-temporal heterogeneity of the UMRS are indeed important to fish community structure. Patch scale variables (e.g. depth and shape of entry cross-section) and hydrological variables at the short-term scale (e.g. duration and magnitude of connection) and long-term scale (e.g. duration and period between connections) influences on both species' presence and species assemblage. Landscape scale variables such as position of habitats in the landscape and proximity to neighbouring habitats do not seem to be important to fish community structure despite their contribution to heterogeneity of the landscape.

Keywords: floodplain complexity, scale, community structure, connectivity.

Multiple approaches contribute to the collection of baseline information on fish biodiversity in remote waterbodies in northern Australia

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The political desire to 'develop the north' that currently exists in Australia has meant that there is an urgent need to collect baseline environmental information on aquatic ecosystems before major developments, including onshore gas, mining, and intensive horticulture and agriculture, proceed. Much of the development in the Northern Territory (NT) is planned for areas that are remote from major human settlements and often difficult to access e.g. on roads that require 4WD vehicles and are often not traversable during the northern Wet season. The three month COVID ban on travel within the NT added to the logistical constraints on sampling waterbodies in 2020. Two consecutive poor Wet seasons also meant that we had a limited period of time to sample waterbodies before they dried completely. These constraints meant that we needed to maximise the information we collected from single visits of limited duration (often <5 hours) to waterbodies. To do this we used both traditional survey methods for fishes (netting and electrofishing) plus eDNA analysis of water (all sites) and sediments (two sites). At all the waterbodies sampled (13) significantly more species were detected using eDNA compared with the netting and electrofishing methods. The sediment eDNA samples yielded less species than the water eDNA samples, possibly due to bacterial consumption/degradation of DNA within the sediments. We concluded that the inclusion of eDNA water sampling will be beneficial in future surveys with similar environmental conditions and limited sampling timeframes.

Characterization of wetland soil colors and redoximorphic features as affected by urbanization and physiography in northern Virginia, USA

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The accurate determination of colors in wetland ecosystems is essential for relating hydrologic regimes and biogeochemical processes to visible soil properties. Methods of color determination, including the Nix Color Sensor, may complement the Munsell Soil Color Chart (MSCC) in documenting soil colors. Identifying the influence of various factors related to wetland functions, including site geomorphology, climate, and watershed landcover patterns. In this study, we first compared color determination methods including the MSCC, Nix through a literature review of studies describing and quantifying soil colors; second, in a 2x2 factorial study design, we utilized both methods of soil color determination to explore the influence of 1) extent of watershed urbanization (urbanized v. non-urbanized) and 2) physiography (Piedmont v. Coastal Plain) on wetland soil colors and their patterns in four Northern Virginia wetlands. Our results indicate that the Nix may appropriately complement the MSCC in hydric soil identification; numerous strong correlations between MSCC and Nix variables were found, including significant linear correlations between Munsell Value and the Nix-measured CIE-Lab L* ($p<0.01$), and Munsell Chroma and both CIE-Lab b* and CMYK Y ($p<0.05$). Next, we determined that wetland soils displayed distinct patterns of soil colors and redoximorphic features depending on watershed urbanization extent and site physiography. Non-urbanized sites contained soils with greater color heterogeneity; deeper initial presence of low chroma colors and iron concentrations; and an average lower chroma of redoximorphic features. Coastal Plain soils also had higher average Munsell values than Piedmont soils, and A its horizons had marginally lower chromas ($0.05<p<0.10$). Overall, soil chroma was not significantly affected by extent of urbanization nor physiography, but a significant interaction was found. Further analysis is warranted to further connect site and watershed characteristics with soil colors.

Degradation of palm swamp peatlands in the Peruvian Amazon severely raises emissions of greenhouse gases

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Palm swamp peatlands of the Amazonia have barely been the subject of biogeochemical investigation despite their large extent and potential to mitigate climate change. In Peru, these ecosystems are suffering recurrent degradation due to slashing of palms for harvesting their fruits. We conducted long-term research to evaluate how this practice affects carbon and nitrogen dynamics across a gradient of degradation that comprised an intact site, a moderately and a heavily degraded site. Site properties and fluxes of above and below-ground litter, soil heterotrophic respiration, and CH4 and N2O were monitored monthly for 1–4 years. Degradation altered the hummock-hollow microtopography of the forest floor, the structure and composition of the vegetation and properties of the soil. Inputs of organic matter to the peat decreased by twofold while outputs increased by 40% as a result of heavy degradation. The net CO2 balance indicated that the peat at the intact and moderately degraded sites was neutral (0.5 ± 5.3 and 2.8 ± 3.6 Mg CO2 ha-1 y-1) but it was a source at the heavily degraded site (25.9 ± 3.4 Mg CO2 ha-1 y-1). Soil CH4 emissions were high (200 kg C ha-1 yr-1) and not affected by degradation. Small site-differences in N2O emissions seemed driven by spatial heterogeneity of soil water-filled pore space. Palm swamp peatlands in their natural state constitute a net source of greenhouse gas (27 ± 8 Mg CO2-equivalent ha-1 y-1). Their degradation leads to increased emission rate by 70% highlighting the urgency to develop sustainable management practices.

Phosphorus fate and management on the Somerset Levels and Moors Ramsar ditch systems

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Eutrophication is a significant threat to surface water biodiversity worldwide, with excessive phosphorus (P) concentrations being among the most common causes. Wetland ditches under these conditions deviate from primarily submerged aquatic vegetation to algae or duckweed dominance, potentially leading to significant biodiversity changes and anoxic conditions. P, from both point (e.g. wastewater treatment works) and diffuse (largely agricultural runoff) sources, is currently a central reason for failure in the majority of surface water bodies in England. However, duckweeds have been shown to be adept at removal of P, where wastewater treatment has been specifically designed to use it. To use duckweed in this way it must be removed and disposed of appropriately, otherwise the duckweed dies, sinks to the bottom and undergoes degradation, releasing previously stored P.
This study assesses the partitioning of P between water column and algae/duckweed and the possibility of 'harvesting' duckweed and algae to reduce internal cycling and to export nutrients from the ditch systems at West Sedgemoor. West Sedgemoor is a designated site of special scientific interest (SSSI), forming part of Somerset Levels and Moors Ramsar site no. 914. Surface vegetation and water samples were collected from 27 sites, processed and analysed for a range of major and minor element constituents, including P. Data suggests surface waters in the system are elevated in nutrients, with total phosphorus (TP) above the current Common Standards Monitoring Guidance target of <0.1 mg/L.

Relationships between land-use practices, geography and global climate change to wetland water quality functions

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Wetland ecosystems play fundamental roles in regulating our freshwater resources, yet they are not comprehensively protected from degradation and loss. West Virginia, USA has wetlands across diverse landscapes and geography that feed into both the Chesapeake Bay and Gulf of Mexico. The state is also comprised of diverse anthropogenic land-use practices. We are assessing 200 wetlands over 2 years to evaluate how watershed land-use practices influence wetland water quality functions. We will also evaluate how global climate change will affect these impacts. Select water quality parameters (20) as well as vegetation, soil and macroinvertebrate composition will be compared with GIS assessments of watershed land cover/ land-use practices, alongside climate data, to evaluate their relationships and determine how they impact a wetland's ability to carry out select functions. Preliminary results after one year of sampling indicate that wetlands at higher elevation with fewer watershed land-use practices generally had lower E. Coli, heavy metal (Lead and Zinc), and nutrient (Phosphorus and Nitrogen) concentrations relative to wetlands at lower elevations with greater watershed land-use practices. Seasonal conductivity readings increased following precipitation events. Conductivity and salinity readings also decreased along its drainage gradient, indicative of the wetland performing its water quality functions. We also observed that conductivity and nutrient concentrations were highest during the winter and lowest during the summer, coinciding with the bottom and peak periods of primary productivity. The results of this project will be used to develop wetland water quality standards for West Virginia, and help advance more comprehensive wetland regulations.

Remote sensing of lacustrine and palustrine wetlands in South Africa under climate change

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Remote sensing (RS) are crucial for monitoring and informed decision making globally, but particularly in Africa. Climate change impacts have shown an increase in the frequency and intensity of drought for sub-Saharan Africa where many communities are highly dependent on rivers and wetlands. The global monitoring of open water systems with RS are in place, yet in temperate to subtropical climates, such as South Africa, where lacustrine wetlands constitute only a tenth of all wetlands. This project assessed whether the freely available Sentinel images can contribute to the improved monitoring of palustrine wetlands in the Grassland Biome of South Africa, and assist in quantifying above-ground biomass, soil moisture content, vegetation communities and the hydroperiod of wetlands. The results showed that the optical and radar Sentinel sensors were able to predict the AGB of wetland vegetation with accuracies comparable to those of WorldView-3. Sentinel-1 and -2 were able to quantify soil moisture along a wetland-upland gradient. Spectra of wetland vegetation were found to be highly separable from upland vegetation, attaining high overall and user's accuracies comparable to, or slightly less than those attained by using proprietary WorldView-3 images. The higher temporal frequency of Sentinel-2, compared with Landsat, improves the determination of the maximum extent of inundated depressions. This is important information for SDG 6.61a reporting, and for characterising hydroperiod classes for the inventory of wetlands. Having free access to these big datasets are important for African countries to enable informed decision making for wetlands.

The spatial and temporal variation of flooding of a coastal freshwater depression along the south coast of South Africa

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With no access to in situ hydrological data for the Nuwejaars catchment, South Africa, satellite imagery from the Landsat archive was processed using the Modified Normalized Difference Water Index (MNDWI). High resolution aerial photographs and an in situ survey weres used in identifying the optimal threshold for extracting surface water. The MNDWI with a threshold of zero had an overall accuracy of 93%. Using the MNDWI with a threshold of zero, images were processed to generate a time series of inundation maps from 1989 to 2019. The 30-year time series of inundation for Soetendalsvlei, a freshwater coastal depression, shows no significant trend of flooding, but displays significant monthly, seasonal and annual variation that is influenced by rainfall variability. A significant positive correlation (R2 = 0.60) between the 18-month Standard Precipitation Index (SPI) and inundation for Soetendalsvlei illustrates the importance of rainfall and antecedent precipitation/storage, but also suggests that inundation may not only be influenced by rainfall variability. The frequency of flooding of wetlands within the catchment varies over time and space, with depression wetlands having a higher frequency of inundation. The characterization of the hydroperiod for Soetendalsvlei, shows permanent, seasonal and intermittently flooded areas that establishes lateral hydrological connectivity within the wetland. The hydroperiod, together with the diverse properties of vegetation, characterizes functional units which supports diverse habitats.