Food and Agriculture Organization of the United Nations

Report of the

Sub-Regional Workshop to Validate the Scoping Study of Nutrient Pollution on the Coastal and Marine Systems of South Asia

21 to 22 May 2014, Colombo, Sri Lanka

Acronyms

BOBLME	Bay of Bengal Large Marine Ecosystem
BOD	Biological Oxygen Demand
BOBP – IGO	Bay of Bengal Programme - Inter-Governmental Organisation
CBD	Convention on Biodiversity
CCD	Coast Conservation Department, Sri Lanka
CDA	Chilika Lake Development Authority
COP	Conference of Parties
FAO	Food and Agriculture Organization
EAF	Ecosystem Approach to Fisheries
EAPM	Ecosystem Approach to Pollution Management
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GOI	Government of India
GPNM	Global Partnership on Nutrient Management
ICZMP	Integrated Coastal Zone Management Plan
IWMI	International Water Management Institute
LOICZ	Land Ocean Interactions in the Coastal Zone
NGO	Non-governmental Organization
OUSL	Open University of Sri Lanka
PC	Partner Countries
SACEP	South Asia Cooperative Environment Programme
SAS	South Asian Seas
SASAP	South Asian Seas Action Plan
SC	Steering Committee
UNDP	United Nation Development Programme
UNEP	United Nation Environment Programme
UNEP-GPA	Global Programme of Action for the Protection of the Marine Environment from Land-based Activities
WB	World Bank
WRST	Water Resources Science and Technology

Table of Contents

Sub-Regional Workshop to Validate the Scoping Study of

Nutrient Pollution on the Coastal and Marine Systems of South Asia

21 to 22 May 2014, Colombo, Sri Lanka

The two day workshop was held as part of a project titled "Controlling Nutrient Loading and Eutrophication of Coastal Waters of the South Asian Seas Region" implemented by SACP/SAS in collaboration with UNEP-GPA and the GEF-funded BOBLME Project of FAO. The main objectives of the workshop were to provide a platform for national authorities and other stakeholders for validating the scoping study of nutrient pollution on coastal and marine systems of South Asia; share experiences and lessons learnt in addressing the current status on mitigating nutrient pollution; agree on a common vision for nutrient pollution management for the South Asian seas; and to test the feasibility of adopting an Ecosystem Approach to nutrient pollution management for the region. Twenty-six participants representing government agencies and international/regional organizations participated at this important event.

The workshop agenda included presentations from collaborative institutions, national governments and resource persons. The draft scoping study on nutrient loading was placed on the table by the consultants, which was followed by group activities. The ecosystem approach to pollution management was tested in the workshop which proved to be an excellent approach to managing the nutrient pollution in the region and the participants agreed on a vision "South Asian Seas free of nutrient pollution by 2020". This vision was further supported by setting targets, hence opportunities for technical and financial support from multi-stake holders are highlighted.

1. Back ground to the Sub-regional Workshop

Nitrogen and phosphorous are important nutrients and their presence determine the productivity of ecosystems. The interest in phosphorus stems from its major role in biological metabolism and the relatively small amounts of it available in the hydrosphere. Although nitrogen can be present in numerous forms, the most significant form of inorganic phosphorus is orthophosphate (PO_4^{3-}). Similarly though nitrogen is abundant, less than 2% is available for organisms, hence reactive nitrogen (Nitrogen bonded to C, O or H) is also a limiting factor. As such, nutrients have been valued as important elements to be introduced into production systems to increase the productivity. It has been known with certainty for decades that Nitrogen (N) and Phosphorus (P) pollution is caused by inefficient agricultural fertilization practices.

While in some parts of the world these two compounds are limiting factors, in other parts excessive usage is becoming a major issue. Especially, the dissolved phosphates and nitrogen compounds are major allochthonous nutrients entering into aquatic systems both horizontally and vertically. The land application of animal waste (poultry litter, municipal sewage sludge and manure) is responsible for half of that nutrient pollution. Since the world food security depends on agricultural and livestock production, in areas of intensive production, fertilizers are added sometimes with little regard to actual needs to soil and water.

Although sustainable landscape management is a component of eco-friendly agriculture and facilitates the unvaried ecosystem functions during agricultural land intensification, and the increasing demand for crop yield, such approaches are hardly seen in practice. As such, we see both the extremes of nutrient pollution issue that is in some areas excess entering into coastal areas as nutrient pollutants and in other areas farmers not having enough nutrients to grow crops. This divide is intensifying as the world population is increasing hence, the actual impacts to ecosystems and the direct and indirect services they provide are being affected.

It has now been scientifically proven that human mediated reactive nitrogen and phosphate input is far greater than the natural inputs to the nitrogen and phosphorus cycles. It has been estimated that approximately 120 million tonnes of reactive nitrogen is produced each year and nearly two thirds of this ends up polluting air, water, soil, marine and coastal areas, and adds harmful gases to the atmosphere. Similarly over 8 times the natural input of phosphorus i.e. 10 million tons of polyphosphates, triphosphates and other reactive phosphates are released to world oceans.

1.1. **Global Partnership on Nutrient Management (GPNM)**

The Global Partnership on Nutrient Management (GPNM) was launched in 2009 based on raised concerns of anthropogenic impacts on global nutrient cycles; this was subsequently echoed by the Delhi Declaration on Reactive Nitrogen Management for Sustainable Development. Decision X/2 of the COP X of the Convention on Biological Diversity adopted the Aichi Targets in which Target 8 of Strategic Goal B says that “By 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity”. But for this to be achieved there needs to be an understanding of the current status of the problem.

GPNM has enlightened the nations and has created transboundary dialogues among stakeholders of common waters and also have identified the ways to responds to this ‘nutrient challenge’ by identifying ways to reduce the amount of excess nutrients in the environment without hindering global development. One key component of this approach is reflecting the need for strategic, global advocacy to trigger governments and stakeholders to move towards more efficient use of nitrogen and phosphorous. This has resulted in within nation revisits to their regulations for sewage management, fertilizer subsidy management and water quality monitoring. The ultimate idea is nutrient proof policy and integrated assessments in all concerned countries.

The Foundations for Sustainable Nutrient Management, a report published by the GPNM, scopes important steps for achieving management goals

- Building a shared interest and agenda among and within countries
- Engaging stakeholders and forming partnerships
- Communicating and mainstreaming best practice tools
- Integrated approaches in order to guide cost effective decision making

1.2. SACEP/BOBLME Initiative for Nutrient Pollution Management

The South Asia Cooperative Environment Programme (SACEP), established in 1982, is an intergovernmental organization mandated for addressing issues of regional significance that are aimed at complementing and supplementing the work being carried out by the member country governments towards protecting the environment. Hosting and coordinating regional arms of international programmes and activities has been a major contributor in terms of bringing in expertise to improve environmental protection mechanisms in the region and in this regard the South Asian Seas Programme (SASP) which is developed under the umbrella of UNEP's Regional Seas Programme in 1995 is highly significant.

The South Asian Seas Region is comprised of the Northern Indian Ocean including the western portion of the Bay of Bengal Large Marine Ecosystem and incorporates the marine and coastal environments of Bangladesh, India, Maldives, Pakistan and Sri Lanka. The South Asian Seas Action Plan (SASAP) was adopted in 1995, with the objective of protecting and managing the marine environment and related coastal ecosystems of the region through the promotion of sustainable development of the resources. The SASP has identified four priority areas where activities need to be developed and implemented: Integrated Coastal Zone Management; Development and Implementation of National and Regional Oil and Chemical Spill Contingency Planning; Human Resources Development through Strengthening Regional Centres of Excellence; and Protection of the Marine Environment from Land-based Activities.

The five South Asian seas countries are home to about one fifth of the world's population, and utilises 4 per cent of the world's coastline. Increasing reports on the number and frequency of algal blooms along the coast and concerns of development of hypoxic zones makes it imperative for nutrient management in these countries. Since large proportion of fisheries depend in on estuarine and near-shore habitats, these habitats are at high risk from nutrient over-enrichment which is a global concern now.

To address the above challenge a project titled “Controlling Nutrient Loading and Eutrophication of Coastal Waters of the South Asian Seas Region” was initiated by SACEP by signing a formal agreement with the GEF-funded Bay of Bengal Large Marine Ecosystem (BOBLME) Project of the Food and Agriculture Organisation of the United Nations. The BOBLME Project Component 4.2. “Coastal pollution loading and water quality criteria - development of a regional collaborative approach to identifying important coastal water pollution issues and to develop remedial strategies” – includes activities to complete, strengthen and/or implement National Plans of Action (NPAs) dealing with pollution issues and pilot activities under the Global Partnership on Nutrient Management (GPNM) in India. BOBLME is collaborating with UNEP-GPA (Global Programme of Action for the Protection of the Marine Environment from Land-based Activities [GPA]) in this regard, and seeks to develop regional and sub-regional partnerships.

BOBLME organized a Regional meeting to share experiences in addressing Land-based sources of Marine Pollution, in relation to development of a Regional Strategic Action Programme for the countries along the Bay of Bengal in Phuket, Thailand, in June 2012. At this meeting SACEP, as the Secretariat for the South Asian Seas Programme, was requested to develop and submit a project proposal to BOBLME, which will address mitigating nutrient loading to the marine environment. This result in the present collaborative project between the two organizations.

The main expected output of the joint activity between SACEP and BOBLME project is the initiation of a process in developing regional level dialogue to address currently unsustainable nutrient management practices to reduce environmental impacts. This activity was presented at the 5th Inter-governmental Meetings of Ministers of the South Asian Seas Programme held in Islamabad, Pakistan, on 5th December 2013 and it received approval. As the initial step, a scoping study was undertaken by a group of consultants (Indian Nitrogen Group) on the nutrient pollution of the coastal and marine systems in the five maritime countries of South Asia. The scoping study (desk study) coved the following areas:

- Various pathways through which the excess nutrients enter the coastal and marine environment

- The background information the critical marine habitats affected legal and policy frameworks that have direct and/or indirect impact on the current Nutrient Use Efficiency (NUE) and what policies are being considered to improve NUE and their merits

- Legal and policy framework, existing water quality objectives, standards and criteria with regard to nutrients loading into coastal waters and how they are monitored

- Present status of nutrient enrichment, freshwater and coastal/marine water quality (with regard to nutrients); any information regarding identified eutrophication hotspots, coastal hypoxic zones and harmful algal blooms (with country specific data and maps and information on negative impact on ecosystem services (livelihoods, food security and impacts on biodiversity)

- National (as well as participation in regional or international/global) programmes or activities to monitor, regulate and report; and institutional mechanisms or arrangements for enforcement of legislations and policies that are in place

- Existing challenges, constraints, gaps and issues (regarding information, policies, implementation and enforcement)

1.3 Objectives of the workshop

The two day regional workshop was held at Galadari Hotel in Colombo, Sri Lanka, from 21 to 22 May 2014 with the following objectives:

1. Provide a platform for national authorities and other stakeholders for validating the scoping study of nutrient pollution on coastal and marine systems of South Asia and to share experiences and lesions learnt in addressing the current status on mitigating nutrient pollution,

2. Agree on a common vision for nutrient pollution management for South Asian seas

3. Test the feasibility of adopting an Essential Ecosystem Approach to Nutrient Pollution management for the region

The Workshop agenda (Refer to Annex 4.1) consisted of informative and technical presentations as well as group discussions. It brought together national experts from the key relevant competent national authorities of the project's beneficiary countries (India, Maldives, Pakistan and Sri Lanka), regional partner organizations, academia and other relevant stakeholders. This enabled the sharing of experiences from on-going regional process, particularly on day 2 during morning session. A full list of the meeting's 26 participants is provided in Annex 4.2.

2. Outcomes of the workshop

2.1. *Inauguration Ceremony*

The Inauguration Ceremony was conducted under the patronage of Hon. Susil Premajayantha, the Minister for Environment and Renewable Energy, Government of Sri Lanka. Ms Beth Crawford, FAO Representative for Sri Lanka and Maldives, was also present at the opening session.

Mr. S.M.D.P. Anura Jayatilake, Director General of SACEP, welcomed the delegates and stated that the countries constituting the SAS Region have almost a fifth of the world's total population. High population density, low income, low development indicators, and high dependence upon natural resources for livelihood characterize all these countries. The major sources of coastal and marine pollution originating from land vary among the SAS countries, which show great disparity in size and demography. The nature and intensity of development activities, human population size, income level, and state and type of industry and agriculture are among the factors contributing to each country's unique pollution problems.

Dr Rudolf Hermes, speaking on behalf of BOBLME Project stated that the Project works towards the common vision of the BOBLME countries: "A healthy ecosystem and sustainable use of marine living resources for the benefit of the countries of the Bay of Bengal Large Marine Ecosystem", that cater for shared desires, including enough fish for future generations; healthy coastal and near-shore marine habitats; and Reduced pollution from agriculture, industry and large coastal cities. Dr Hermes also stated that the present regional workshop highlights and underlines the importance of three major concerns of the BOBLME Project, namely: regional cooperation, capacity development and knowledge management.

Dr Hermes speech was followed by the address by the Chief Guest, Hon Susil Premajayantha, M.P. Minister of Environment and Renewable Energy. Hon Minster welcomed the delegates and congratulated SACEP and BOBLME project for undertaking the important event. He further stated that the Government of Sri Lanka has embarked on a rapid development agenda after successful eradication of terrorism in 2010, covering in all the sectors of economy namely tourism, urban and infrastructure development, industrial development, aviation and naval development. In this development scenario, Government of Sri Lanka has also acted towards maintaining the good health and productivity of the marine environment through several legislative enactments, policies, programmers and projects. Full speeches are provided in Annex 4.3

2.2. **Technical Sessions – Day 1**

2.2.1. ***Presentations by Workshop Collaborators***

Mr S M D P A Jayatilake, Director General, SACEP, commenced the technical session with a presentation titled “SACEP’s Initiatives for Addressing Marine Pollution in South Asia “. The DG stated that protection of the marine environment from land-based activities has been identified as one of the four priority areas to be addressed under the SAS Action Plan and therefore has been an activity actively perused by SAS since 1997 with the assistance of UNEP-GPA office (Refer to Annex 4.4).

Next to make a presentation was Dr Rudolf Hermes and he presented an overview of the Bay of Bengal Large Marine Ecosystem Project. Dr Hermes stated that the expected outcomes of the BOBLME project were: improved governance of fisheries and environment; more effective regional cooperation; an enhanced knowledge base; capacity development; and implementation of the Ecosystem Approach to Fisheries (EAF) management. His full presentation is given in Annex 4.4.

2.2.2. ***Country Presentations***

Next in agenda were the country presentations by national delegations on current status of Mitigating nutrient pollution to marine and Coastal waters of their respective countries. The presentations were followed by a question and discussion session. Specific outcomes from all the country presentations common to South Asia are:

1. Vast discrepancies in regulations for tolerable levels though waters are shared
2. Inadequacy of trained man power for implementation of existing regulations
3. Inability to identify the point sources

4. Lack of technical capacity and formally adopted internationally accepted procedures for water quality monitoring
5. Lack of stakeholder engagement especially at agriculture, environment and fisheries sector.
6. Visions of ministries mentioned above being significantly different, hence inability to formulate joint actions
7. General public still perceiving the ocean as the ultimate receiver all dumped matter
8. Governments not proactive in awareness
9. Data sharing problems between the countries

Given below is a brief summary of each country presentation. The full presentations are given in Annex 4.4.

- INDIA

Sea of India is situated in between two ocean systems, Arabian Sea and Bay of Bengal. Arabian Sea experiences strong upwelling and have reports of natural hypoxic conditions in the western coast. Reports on the eutrophication of estuaries and coastal waters are available from a few places. Research conducted by Ministry of Earth Sciences has confirmed that a large natural hypoxic zone develops seasonally over the Western Indian sub-continental shelf, likely due to N loading. However the presenters indicated that the contribution of upwelling and sediment transport to Indian nutrient loading is largely unaccounted for hence needs future investigations. However several blooms have been documented.

So far 452 species of microalgae have been identified (229 diatoms, 198 dinoflagellates, 16 blue green algae and 9 other groups: S*ilicoflagellates, Chlorophytes, Coccolithophorids, raphidophytes, prymnesiophytes and prasinophytes*). Of that, 86 are bloom-forming species with 45 potentially toxic species.

- MALDIVES

It was stressed that marine resources are the main natural endowment with economic activities concentrated on fishing and tourism in Maldives. However unlike other partner countries there are no inland fisheries and no organized agriculture releasing nutrients to coastal water. It was also stressed that fishing operations take place in offshore, coastal and reef waters and on boat processing of tuna is a current practice. In the Maldives, sewage is considered to be the major source of pollution. Raw sewage is directly discharged into sea. Some level of sewage management is in place in tourism sector, however sewage treatment especially the septic tanks have also created issues with ground water. There is also a growing concern about groundwater pollution due to improper use of fertilizers in some islands. Currently, out of 199 inhabited islands, only 35 islands have sewerage systems. None of the islands have treatment plant hence in these islands raw sewage is discharged directly to marine environment

It is also mandatory for all the resorts to have sewerage systems and treatment plants and that remaining water is discharged to the marine environment or used in irrigation. A handful of algal bloom and fish kill events have been reported in the last 30 years, all of them are isolated incidents and relationships between these fish kills and nutrient pollution have not been proven.
It was also noted that in recent years several regulatory measures have been proposed and implemented by Maldives to address nutrient pollution, namely Maldives Environment Protection & Preservation Act of 1993, Environment Impact Regulation 2012, Regulation on Environmental Liabilities 2011 and Waste management regulation 2014. However, it was highlighted that due to geographic distribution of the islands it is a challenge to monitor pollution and carry out assessments.

- PAKISTAN

Pakistan is the home to the Indus Delta which is the seventh largest in the world covering an area of 600,000 ha. Approximately, 20 major and hundreds of small creeks are present in Pakistan. The highest river discharge is in July due to melting of snow in Himalaya. It was noted that the Sindh coastal belt suffers from serious environmental problems including nutrient pollution. Amongst different sources, metropolitan municipal sewage and industrial effluents are the two major sources of coastal water pollution. Currently an estimated BOD load of 1500 tons/day is added into the sea by industry. Pollution loads which mostly originate in creeks (Korangi, Phitti, Kadiro and Gharo creeks) in the southeast of Karachi as a result of discharge of domestic and industrial wastes are responsible for the elevated nutrient levels. Effluents of more than 6000 industrial units located in six big industrial estates are discharged into Karachi coastal waters through Malir and Layari rivers.

It was also noted that several policies and regulations are in place for nutrient pollutant discharge management such as, National Environment Policy, 2005 (also known as NEP-2005); Integrated Coastal Zone Management Plan (ICZMP) for Pakistan, 2011; Pakistan Environmental Protection Act, 1997 etc. However, lack of compliance to regulations was noted as a main challenge and the need to update some of the regulations was also highlighted. Pakistan also mentioned the need for agreed analytical methods for monitoring within the region thus enabling comparisons.

- SRI LANKA

Agriculture, aquaculture, poultry and livestock farming and sewage were highlighted as the main factors of nutrient pollution in Sri Lanka. The recent developments in agriculture policies such as fertilizer subsidy, crop diversification and extension of shrimp farming along the coastal areas were mentioned as some of the current concerns of Sri Lanka. However it was noted that the cascade systems have complex nutrient dynamics and as such if these anthropogenic activities have resulted in elevating the main nutrient pollutants is debatable. However in areas such as Puttalam peninsular coastal aquifers, an important source of drinking water appears to be contaminated by nutrient pollutants showing a clear correlation with anthropogenic activities, mainly agriculture. Sri Lanka has shown a steady increase in fertilizer use over the last 9 years.

Sri Lanka has several regulations mainly the water quality regulations gazetted by the Central Environmental Agency and also Environmental Impact Assessment (EIA) regulations for large scale agricultural developments to adhere to EIA procedures. However, the lack of data collected according to accredited procedures, low implementation of regulations and lack of awareness were highlighted.

2.2.3. Group work Sessions 1 and 2

The country presentations were followed by two sessions of group work:

1. Self-check on current national and regional status of nutrient pollution management in the region - the following regional and global initiatives were identified

- International Nitrogen Initiative - http://initrogen.org/
- UNEP – GPA - Global Partnership on Nutrient Management (GPNM)
- Land Ocean Interactions in the Coastal Zone (South Asia node) http://www.loicz.org/
- Indian Nitrogen Group - http://ing-scon.org/?q=node/16
- BOBLME Project - http://www.boblme.org/
- Regional Seas – South Asian Seas Programme (SACEP)

2. Identification of national and regional challenges and opportunities for nutrient pollution management - participants had group discussions to identify the gaps in knowledge and the outcomes are:

- Nutrient loadings to South Asian seas from upwelling and sediment transfer
- Non point sources
- Knowledge about the chemical, physical, hydrological and biological processes taking place in estuaries, marine habitats, coastal waters
- Role of micro-organisms in regulating nutrients
- Seasonal and annual variation in pollution loads from land-based activities
- Extent of contamination of coastal sediments
- Exact procedures to measure nutrients in sea water
- Coverage, treatment types, and discharge data for urban sewerage systems

- Impact of coastal aquaculture, poultry and livestock sector
- Nutrient loadings from ballast water
- Information on bioaccumulation, bioconcentration, biomagnification and trophic transfer of critical pollutants
- Role of marine habitats such as mangroves, sea grass beds etc. on nutrient regulation
- Motivational factors for fostering pollutant sensitive South Asian population

2.2.3. *Introduction to the draft scoping study by consultants*

Indian Nitrogen Group representatives presented the overview of their scoping study; following is an extract from the executive summary of the said report. The full presentation is provided in Annex 4.5.

The five South Asian countries namely, Bangladesh, India, Maldives, Pakistan and Sri Lanka are the home to about 22% of the global population, with only 4.8% of the world's land mass, 14% of the global arable land, 2.73% of the world forest area and 4% of the world's coastline. For this region like many other regions of the world, availability and use of nutrients is the key to ensure food security, hence it cannot afford to lose precious nutrients required for food production as pollutants to the environment. Notwithstanding the above, the coastal habitats of South Asia are at a high risk of eutrophication from nutrient enrichment due to leakages from agriculture, aquaculture, sewage, industrial effluents, marine trade and transport.

This desk study examined the problem of eutrophication of coastal waters for the countries of South Asia.[1] *With over 94% of arable land already under cultivation, food production in both rain-fed agriculture and irrigated areas depends on the use of fertilizers and nutrients, at a varying scale, such as compounds of reactive nitrogen (N) and phosphorus (P), which often leak into the environment from cropping, aquaculture and livestock systems. Nutrients are also lost through sewage in densely populated areas along the major watercourses, where sewage treatment is mostly unavailable and/or inadequate, except in a few large cities and towns. Increasing contribution of reactive nitrogen compounds from the burning of fossil fuels in power generation and transport are also of concern. Together, they adversely affect the soil, water and air quality, health, biodiversity, ecosystem services including aquatic, estuarine, coastal and marine ecosystems and often contribute to climate change.*

1 South Asia is also oceanographically significant, with two seas of opposite circulation physically separated by the Indian peninsula. The Bay of Bengal maintains a clockwise circulation of major currents during both the northeast and southwest monsoons while in the Arabian Sea it reverses with surface water masses circulating counter clockwise in the northeast monsoon and clockwise during the southwest monsoon.

Bangladesh, with a coastline of 734 km generates 600 tons of waste from its shrimp culture alone with mean levels of nutrients at 108.78 mg/l for $CaCO_3$, 0.526 mg/l for NH_4^+ -N, 3.075 wt% for organic carbon, 7.00 mg/l for PO_4-P and 5.57 mg/l for NO_3-N. In addition, a huge amount of pollutants released from its 8,542 industrial units contains 11-22 μg/kg dissolved or dispersed hydrocarbons or particulate petroleum residues in the surface water and 14-23 μg/kg in subsurface water. India, with the longest coastline of 5,423 km contributes around 50 billion litres of industrial effluents, 30 billion litres of sewage, 5 million tonnes of fertilizer residues, 3500 tonnes of petroleum hydrocarbons and 0.2 million tonnes of mining rejects, dredged spoils and sand extractions. In Maldives with 26 coral atolls, contamination from direct disposal of sewage wastes from tourist trade constitutes the major source of pollution, coupled with the global traffic of petroleum transport along the sea routes.

Pakistan, with about 990 km long coastline contributes to coastal pollution mostly through direct discharge of industrial effluents and domestic sewage in the ratio of 60:40. In the Karachi coast alone, an estimated BOD load of 1,500 tons/day is added into sea by these industries in addition to inorganic pollutants. Discharges of 130,000 tons of solid nitrogen, 160,000 tons of organic matter, 800 tons of nitrogen compounds, 90 tons of phosphate compounds and 12,000 tons of suspended solid every year, is encountered in Manora Channel in the Karachi coast. Further, being on the gateway of Persian Gulf, transport of crude oil constitutes other major source of coastal pollution in Pakistan.

Sri Lanka, an island nation with 1,620 km coastline with agriculture and aquaculture as the cornerstones of the country's economy, pollution of coastal waters from agrochemicals contributes the major share with nitrate-N reaching 0.11-5.7 mg/l and phosphate at 0.11 -0.78 mg/l in coastal aquifers. Shrimp farms also release effluents with high levels of suspended solids (200-600 mg/l) and high BOD levels (60-180 mg/l).

Signs of degradation of aquatic, estuarine, coastal and marine ecosystems due to nutrient loading are evident at various locations in South Asia, with several reports on eutrophic zones due to excessive growth of algae and fish kills due to hypoxia. Estuarine and coastal systems in South Asia are N-limited and N loading can trigger algal blooms and eutrophication. Some of the estuaries, especially along the Indian east coast, are phosphorus limited and are adversely affected by P loading. The Western side of the Indian peninsula is already prone to seasonal development of natural hypoxic zones, whereas the East coast is relatively less prone to hypoxia. Additionally the hydro-dynamics of the region (see footnote 1) often makes the situation complex and at times even invisible. Agricultural nutrient loading to coastal waters is primarily during rains/floods, whereas sewage is the single main source of pollution of coastal waters from the land. Nutrient leakage from fisheries, aquaculture and livestock farming is also high, especially in areas of intensive aqua-farming.

Thus, while the sources of nutrient pollution and their degree of loading as well as the data quality and availability vary at different locations, there are clear overall indications of the *effects of nutrient pollution throughout South Asia and a few of them could be of transboundary in nature. All the coastal countries of the region are signatories to various international treaties and are in agreement on implementing the international standards of coastal water management. They have institutional mechanisms for pollution control at multiple levels (central/state/local) but their success is limited by the level of enforcement. However, the most crucial factors of governance that contribute to nutrient pollution across the region are inadequate emphasis on nutrient use efficiencies and environmental standards in agriculture, poor sewage management and inadequate recognition that some pollutants are nutrients essential for food production.*

The situation merits strong national and regional interventions for thorough assessment to understand the extent and scale of the problem as well as to define remedial actions that could be pursued at various levels. Some key recommendations are proposed below, based on an analysis of secondary literature and gray materials available to the study team.

Recommendations

1. *Nutrients such as Nitrogen and Phosphorus that are necessary for food production should be retained or recycled into food production, as they become pollutants if lost into the environment.*
2. *The existing policies and practices of agriculture, sanitation, industry and environment do not sufficiently emphasize nutrient efficiencies and sustainable nutrient management to prevent nutrient pollution and eutrophication of aquatic and coastal ecosystems*
3. *The available information on nutrient losses from various human activities and their accumulation in the coastal zones of South Asia is very limited. This calls for detailed studies with actual long term measurements and simulation of nutrient pollution from source to sink (land to sea) for informed decision-making*
4. *Systematic studies should be initiated to quantify the sources, flows, fate and extent of current industrial, agricultural and municipal effluents and the nutrients they contribute to water bodies and their impacts on aquatic life, fishing as well as human health.*
5. *Methodologies and mechanisms should be developed for collection and sharing of data on the nutrient pollution status in different coastal regions of South Asia.*
6. *Sustained efforts are needed for increasing nutrient use efficiency, land and water productivity to improve agricultural productivity, sanitation and reduce pollution.*
7. *Land-based pollution should be minimized through integrated land use planning and land zoning for recycling of waste materials.*
8. *The nutrient load in the estuarine and brackish water fisheries and its impacts on fish catch, landing, species composition and seasonality, ecosystem productivity and human health need to be assessed to limit adverse impacts.*
9. *Capacity building is needed for sustainable fishing and aquaculture with integrated resource management to protect them from environmental degradation and encroachment on the livelihood rights of fishermen*

10. *Pollution from ships and other transport systems as well as ship breaking industry should be tightly regulated through rigorous environmental impact assessment*

Policy options

Governance responses to the problem of nutrient pollution requires fine tuning and enforcement of existing policies, as well as framing specific policies/programmes designed to enhance nutrient use efficiencies, recover and recycle nutrients. The following policy options could be considered to combat nutrient pollution of aquatic, coastal and marine environment:

1 *Nutrient use efficiency and site-specific nutrient management should be emphasized in the existing policies and programmes in all aspects agriculture, aquaculture, poultry, livestock farming to minimize nutrient leakages throughout the food chain. They should be enforced and monitored periodically through a joint task force comprising relevant scientific, administrative and civil society stakeholders.*

2 *Sustainable nutrient management should be emphasized, enforced and monitored as above in the existing policies and regulations on municipal wastes, industrial effluents etc., specifying nutrient contamination limits and mandating their recovery and recycling.*

3 *Effective policies are needed for land zoning of industries, strengthening sanitation and water quality monitoring with enforcement of the environmental conservation policies on waste treatment and nutrient recycling at all point sources.*

4 *Policies for phasing out of phosphate containing detergents and other products that tend to cause nutrient loading of the environment in general and water bodies in particular.*

5 *National Sewage treatment missions should be initiated with specific annual targets and provisions for public reporting of progress and civil society oversight, to protect water bodies from nutrient, organic and other pollution*

6 *Innovative new policies to combine the social benefits of eradicating open defecation with technologies (such as composting toilets or treatment plants) for recycling human wastes as fertilizers, along with awareness programmes to highlight the health hazards of untreated use of human excreta (or sewage contaminated with them) for crop production*

7 *Marine Protected Areas should be identified in the coastal areas and conserved, involving governmental, non-governmental and community participation.*

8 *National marine environment research institutions should be established/ strengthened with specific mandate for coastal zone pollution studies and nutrient pollution abatement in each of the south Asian countries, with mechanisms for collaboration and data sharing.*

9 *Each South Asian country should have a national level inter-ministry and inter-agency multi-stakeholder coordinating body for effective policy formulation and implementation of sustainable nutrient management involving relevant national and local governmental bodies and non-governmental organizations, scientists, engineers, industry and civil society to combat coastal pollution.*

10 *There is a strong need for a South Asian level intergovernmental working group/task force for coordinated sustainable nutrient management and protection of the region's coastal and marine environment, with governmental and civil society representatives from the above national bodies. This may work within, or coordinate with the existing intergovernmental*

processes, including the UNEP-GPA, SAARC, the BOBLME project etc. and build on them for stronger regional cooperation on nutrient management.

Since several important constructive comments were received from the participants it was decided to circulate the draft among the participants and obtain their comments prior to adoption. The need for updated data and outcome based objectives were also pointed out and the Indian Nitrogen Group agreed to revise the scoping report accordingly.

2.3 Technical Session – Day 2

After presenting an overview on the Day 1 activities, up to morning tea break six presentations were made on different aspects of the nutrient loading to coastal zone by invited resource persons. A brief summary of each presentation is given below. Annex 4.6 provides the full presentations

Presenter	Topic	Brief Summary
Dr Anjan Datta (Former coordinator/GPA)	New direction in implementing the GPA &Global Partnership on Nutrient Management (GPNM)	The Manila Declaration in 2012, mandated the establishment of three partnerships; nutrients, marine litter and waste water; the role of GPNM is twofold: to innovation and knowledge regeneration to reduce nutrient losses; and improve overall nutrient use efficiency 20% relative improvement in NUE by 2020 would lead to an annual saving of around 20 million tonnes of nitrogen
Dr Javier Mateo-Sagasta, IWMI	Waste water and septage: turning an environmental hazard into a safe asset-	IWMI holistic work on pollution control includes Resource Recovery and Reuse. Case studies from Bangladesh (Agricuatics, Mirzapur, duck weed fertilized fish ponds) and Sri Lanka (Seepage management) were presented
Dr. A.K. Patnaik Chief Executive CDA	Ecosystem Health Report Card - an Effective tool for management of coastal & marine ecosystems	Chilika Lake is the 1st Ramsar site of India and is a hotspot for biodiversity was degraded. Hydrological interventions lead to improved resource base and quality of the lagoon. Environmental report cards are transformative assessment and communication products that compare environmental data to scientific or management thresholds and are delivered to a wide audience on a regular basis. Overall, Chilika Lake scored "B" for ecosystem health.
Dr Bandunee Athapattu, OUSL	Modelling nutrient flux to inland and coastal waters	Case studies in Sri Lanka- Nutrient fluxes from paddy cultivation to surface waters and Impact of Climate Change on Runoff was presented
Dr Anil Prmaratne, CCD,	Coastal water pollution issues and management	Water regimes relevant to coastal pollution include: rivers and streams, estuaries and lagoons, ground water and the ocean.

Sri Lanka	measures	Key sources of the nutrient pollution in the coastal area are: municipal domestic sewage, industries, agriculture and aquaculture, squatter settlements. Existing management mechanisms includes environmental standards, EIA, and IEE, issue of EPLs, prohibitions and research
Prof. Ivan Silva WRST	Reactions of algae to nutrient pollution	Algal blooms were recorded from the Kotmale reservoir, Kandy Lake etc., bloom development differs in shallow irrigation reservoirs and deep hydropower reservoirs. Tropical lakes are nitrogen limited

3. **Application of an Ecosystem Approach to Pollution Management (EAPM) in South Asian Seas**

The main feature of the 2 day workshop was the participants applying Essential Ecosystem Approach to Pollution Management. This is the first time a variation of EAFM (Ecosystem Approach to Fisheries Management) was adopted in Asia for another environmental issue other than fisheries. This workshop has a significant outcome as it is the first attempt in testing EAPM. This approach is based on three key outcomes to ensure sustainability (Fig. 1). The full presentation is given in Annex 4.7

Figure 1: Expected outcomes from EAPM

Countries independently ranked the current application of seven principles of EAPM. Later they ranked the same to SA and the mean scores were taken. The results indicated lack of adaptive management and management happening at inappropriate scale (Fig. 2). All countries agreed the need to address the transboundary nature of pollution.

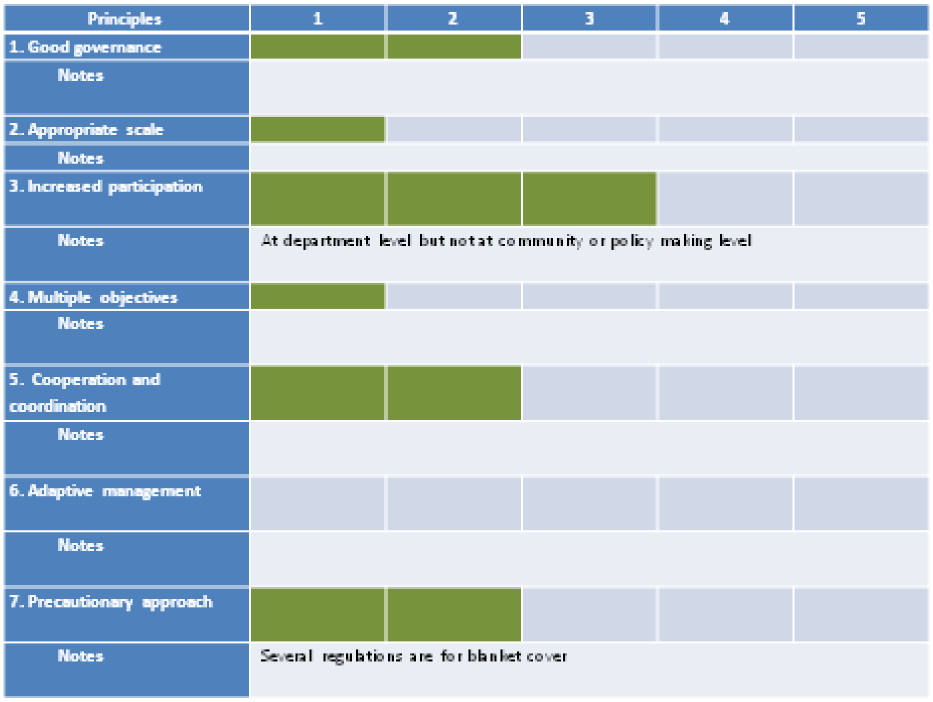


Figure 2: Current level of adoption of seven principles of EAPM

3.1. **Action Plan**

Accordingly, the participants agreed on a vision for nutrient pollution management in the South Asian Seas region

Vision

South Asian Seas free of nutrient pollution by 2020

The participants also agreed on following goals to achieve the above vision

1. Establish use-dependent ambient marine water quality standards for the SA seas and implementation of such regulations with greater transparency between countries
2. Enhance the nutrient efficiency and recovery in the agriculture, livestock, poultry and aquaculture sectors
3. Improve the management of nutrient recovery in sewage
4. Improve waste disposal mechanisms in major and minor harbors and fish landing sites
5. Efficient solid waste management through enhanced awareness and opportunities

In order to achieve the above goals following actions were also agreed upon. Each agreed action is outlined in tables given below (Table 3 A, B, C, D, and E).

Table 3A: Goal 1

Establish use- dependent ambient marine water quality standards for SA seas and implementation of such regulations with greater transparency between countries

Action	**Lead agency in initiation of action**	**Duration**	**Comments**
1. Establishment of a regional Steering Committee (SC)	SACEP	Within 1 year of adoption	Facilitated by an independent regional project such as BOBLME
2. Establishment of a regional Technical Committee under SC and conducting a trans boundary diagnostic analysis of nutrient pollution	SACEP/ Partner countries / SC	Within 2 year of adoption	
3. Agreeing on physico-chemical and biological parameters to monitor and tolerable levels for use dependent areas	National	Within 3 year of adoption	
4. Adopting by the partner countries (PC)	PC	Within 5 year of adoption	
5. Identification of agencies, provision of infrastructure and capacity development	PC, Financiers, Training bodies	Within 5 year of adoption	
6. Evidence based action through stakeholder participation and awareness	Regional and global agencies	Within 5 year of adoption	

Table 3.B: Goal 2

Enhance the nutrient efficiency and recovery in agriculture, livestock, poultry and aquaculture sector

Action	**Lead agency in initiation of action**	**Duration**	**Comments**
1. Establishment of a mediator facilitated forum for diagnostic analysis	SACEP UNEP FAO	Within 1 year of adoption	A mediator is highlighted here due to diversity of stakeholders and differences in their current policies
2. Production of a report and action plan by production, environment and fisheries sector using EAPM principles	Partner countries	Within 2 year of adoption	Finances for stakeholder engagement is essential

3. Adopting institutionalized incentives for reduced use of fertilizers	PC	Within 5 year of adoption	
4. Improving the capacity to cap pollutants at point sources	PC, Financiers, Training bodies	Within 5 year of adoption	
5. Introduction of poly culture and other nutrient retention techniques for nutrient recovery at the production sites	Regional and global agencies	Within 5 year of adoption	
7. Improving /creating market for organically produced food	Partner country, regional trade associations	Within 2 year of adoption	
8. Improving post-harvest losses through regulations and awareness	PC, FAO, BOBP-IGO	Within 5 year of adoption	
9. Promoting nutrient efficient crops / animals	PC, Financiers, Training bodies	Within 5 year of adoption	

Table 3.C. Goal 3
Improve the management of nutrient recovery in sewage

Action	**Lead agency in initiation of action**	**Duration**	**Comments**
1. Establishment of effluent water quality standards for SA	SACEP	Within 1 year of adoption	
2. Introduction of nutrient efficient sewers	National level efforts from PC with funding from WB, UNEP, UNDP	Within 3 year of adoption	
3. Improving opportunities to use recovered nutrients at national levels	PC	Within 5 year of adoption	Capacity development and strengthening the infra-structure should be done parallel to action 3
4. Creating awareness and capacity building on treated sewer discharge options to open sea	PC, Financiers, Training bodies	Within 5 year of adoption	

Table 3.D. Goal 4 ***Improve waste disposal mechanisms in major and minor harbors and fish landing sites and food processing centers***			
Action	**Lead agency in initiation of action**	**Duration**	**Comments**
1. Enhancing the facilities at major and minor harbours, fish landing sites and in food processing sector for waste disposal and prevention of raw and processed food entering into water bodies through facility development, improved monitoring, regulations, participatory action plans, self-reporting, incentives and product certification	SACEP / Relevant ministries in PC	Within 1 year of adoption	Multi-stakeholder engagement and participatory approaches should be attempted along with improved monitoring
2. Improving the post-harvest techniques and recovery of nutrients in waste water	National	Within 3 year of adoption	
3. Strengthening the recycling agencies and creating markets	PC	Within 5 year of adoption	
4. Establishing markets for by products from food waste	PC, Financiers, Training bodies	Within 5 year of adoption	
5. Improve the market for minimally processed food and earth friendly food products	Regional and global agencies	Within 5 year of adoption	

Table 3.E. Goal 5 ***Efficient solid and liquid waste management through enhanced awareness and opportunities***			
Action	**Lead agency in initiation of action**	**Duration**	**Comments**
1. Country specific gap analysis and regional gap analysis on SWOT of current practices of solid and liquid waste mgt. in relation to nutrient pollution in seas.	SACEP facilitated regional forums	Within 1 year of adoption	It emerged that within the partner countries there are lessons that could be shared for improved solid waste management in production, industry sector and household level

2. Preparation of a regional diagnostic analysis	Regional Steering committee	Within 3 year of adoption	
3. Adopting an action plan based on DA using EAPM	PC	Within 5 year of adoption	
4. Establishment of national actions and monitoring systems	PC, Financiers, Training bodies	Within 5 year of adoption	
6. Improving M and E	Regional and global agencies	Within 5 year of adoption	

3.2. Stakeholders of EAPM

The participants also identified the most important and most influential stakeholders in addressing the nutrient pollution in SA seas:

1. Ministry / Department of Agriculture
2. Ministry / Department of Environment
3. Ministry / Department of Fisheries and Aquaculture
4. Ministry / Department of Industry and Commerce
5. Ministry / Department of Agriculture, Fisheries, Livestock extension and promotion
6. Ministry / Department of Harbour
7. Ministry / Department of coast conservation
8. International, regional and national level fertilizer producers and distributors
9. International, regional and national level animal feed producers and distributors
10. International, regional and national level NGO's and opinion leaders
11. Tourists and tour operators
12. Agriculture farmers
13. International, regional and national level funding agencies
14. Researchers, academics and research institutions

Participants unanimously agreed to the need for initiating dialogues supported by SACEP to implement EAPM in SA to achieve the vision.

3.3. Conclusions and Recommendations

1. South Asian countries are reporting increasing level of nutrient pollution, despite having several regulations to control nutrient pollution.

2. The policy differences in agriculture, livestock, fisheries and environment sectors coupled with lack of cooperation has further escalated the issue.

3. There is a serious knowledge and data gap on the chemical, physical, hydrological and biological processes taking place in estuaries, marine habitats and coastal waters in relation to nutrient dynamics, point and non-point sources. Accordingly there is a need to address the knowledge and data gap prior to initiation of transboundary and in country action plans. More and more national level actions are needed to fill this gap.

4. Opportunities should be created for stakeholders to involve in nutrient pollution management initiatives in their respective countries. The most important and the influential stakeholders agreed by were the policy makers, officials of agriculture, fisheries and environment sector, fertilizer manufacturers and distributors, agriculture farmers, poultry, livestock, aquaculture farmers and food processors and urban development/ waste management authorities.

5. Ecosystem approach to pollution management (EAPM) is an excellent proven approach to managing the nutrient pollution in the region. A vision "South Asian Seas free of nutrient pollution by 2020" was agreed and needs further discussion and fine tuning. The vision supported national and regional targets, and also creates opportunities for technical and financial support from multi-donors and stakeholders.

4. Annexes

4.1. Workshop Agenda

Day 1 – Wednesday 21st May	
08:30 - 09:00	Registration of Participants
09:00 - 09:45	**Inauguration Ceremony** - *National Anthem* - *Lighting of the Oil lamp* - *Welcome Remarks – SACEP* - *Introductory Remarks – FAO/BOBLME Project* - Address by the Chief Guest, Hon Susil Premajayantha, M.P. Minister of Environment and Renewable Energy
09:45 - 10:15	*Tea break and Group Photograph*
10:15 - 10:25	Workshop arrangements and Self introduction of the participants
10:25 - 10:35	SACEP's initiatives in addressing marine pollution in South Asia
10:35 - 10:45	Introduction to BOBLME Project and its activities
10.45 - 12:40 -	Country presentations (as per template) on current status of Mitigating nutrient pollution to marine and Coastal waters (15 minutes for each country for presentation and questions/discussion session) *Bangladesh, India, Maldives, Pakistan, Sri Lanka*
12.40 - 13.00	*Group work – Session 1 – self check on current national and regional status of nutrient pollution management in region –*
13:00 - 14:00	*Lunch Break*
14.00 - 14.10	*Group Work – Session 2 –* Identification of *national and regional* challenges and opportunities for nutrient pollution management
14:10 - 15:00	Introduction to the draft scoping study by consultants followed by discussion
15.00 – 15.30	*Group works session 3 – national and regional listing, plotting and understanding the linkages of stakeholders*
15:30 - 16:00	*Tea break*

16:00 - 17:00	Creating good governance - Identifying the broad Pollution Management Unit - Establish key stakeholder group - Agree on Vision - Scope (existing data/must have data/good to have data) Group presentations
Day 2 - Thursday 22nd May	
09:00 - 09:15	Summary of Day 1 and introduction to Day 2
09:15 - 09.30	New direction in implementing the GPA & Global Partnership on Nutrient Management (GPNM)– Dr Anjan Datta
09.30 - 9:45	Wastewater and septage: turning an environmental hazard into a safe asset- Dr Javier Mateo-Sagasta, IWMI
9.45 - 10.00	Chilika Ecosystem Health Report Card - Dr. Ajit Kumar Pattnaik, Chilika Lake Development Authority
10.00 – 10.15	Coastal water pollution issues and management measures -Dr Anil Premaratne, Coast Conservation Department of Sri Lanka
10.15 – 10.30	Modelling nutrient fluxes to inland and coastal waters – Dr Bandunee Athapattu , The Open University of Sri Lanka
10.45 - 11.00	Reactions of algae to nutrient pollution – Prof Ivan Silva
	Tea break
11.00-13.00	Ensuring the ecological and human wellbeing through good governance - understanding the drivers, threats and issues - Prioritising the threats - Goals - Reality check
13:00 - 14:00	Lunch break
14.00 - 15.000	Ensuring the ecological and human wellbeing through good governance - Objectives - Indicators - Baselines and bench marks - Action Plans

	- Action plan Compliance to national/regional policy - Seeking finances
15:00 - 15:30	Group presentation and discussion
15:30 - 16:00	Tea break
16:00 - 1630	Reality check Action plan for monitoring and evaluation
16:30 – 16:45	Recommendations to partners
16:45 - 17:00	Closing remarks by BOBLME and SACEP

4.2. Workshop participants

Country Delegation

- **India**

1. Dr Sivaji Patra, Scientist, ICMAM, Chennai
Scientist-D, ICMAM- Project Directorate
NIOT Campus, Pallikaranai, Chennai -600100, India
Tel: (O): 044 66787500
MOBILE: +91 9445008684
sivajipatra@icmam.gov.in

2. Dr Anil Kuma Vijayan, Scientist C
Centre for Marine Living Resources And Ecology (CMLREmlre),
Ministry Of Earth Sciences,
Block C, 6th Floor, Kendriya Bhavan
Kakkanad, P.B.No.5415, P.O.Csez, Kochi, Kerala-682037, India
Tel: +91-484-2422016 (Office)
email: anilkumarvijayan@yahoo.com; anilkumarvijayan@gmail.com
URL: www.cmlre.gov.in

- **Maldives**

3. Mr. Mohamed Musthafa
Director/Environmental Protection Agency, Maldives
Green Building, Handhuvaree Hingun,
Maafannu 20392, Male, Republic of Maldives
mohamed.musthafa@epa.gov.mv

+960 7782393
+9603314751 (office)

4. Mr. Rifath Naeem
Senior Environment Analyst/Environment Protection Agency
Green Building, Handhuvaree Hingun,
Maafannu 20392 Male
Republic of Maldives
rifath.naeem@epa.gov.mv
+960 9889989
+960 3335949 (office)

- **Pakistan**

5. Ms. Parveen Ejaz
Deputy Director (Biodiversity)
Climate Change Division, Cabinet Secretariat,
LG & RD Complex, Pakistan
parveen_ejaz@live.com
+92 0321 2772153
+92 0519 245586 (office

6. Prof. Dr. Ghazala Siddiqui,
Centre of Excellence in Marine Biology, University of Karachi
Ghazala_siddique@hotmail.com
+92 034 522 50409
+92 21 99261 551 (office)

- **Sri Lanka**

7. Mr. P.L.A.M.C. Wijewarnasooriya,
Marine Environment Officer
Marine Environment Protection Authority (MEPA)
0779449873
94 11 268 745 / 461 5960 (fax)
asankamn@gmail.com

Observers

8. Prof. Ruchira Cumaranatunga
Senior Professor of Fisheries Biology,
Dept. of Fisheries & Aquaculture,
Faculty of Fisheries and Marine Sciences & Technology,
University of Ruhuna, Matara.

Phone: +94(0)41 2227026, +94(0)777285960 (mobile)
e-mail: ruchira@fish.ruh.ac.lk; ruchiracum@gmail.com
fax: +94(0)41 2227026

9. Arjan Rajasuriya
Project Manager (SL), MFF Regional Project, Gulf of Mannar
Coordinator, Marine & Coastal Thematic Area
IUCN Sri Lanka Country Office
email: arjan.rajasuriya@iucn.org

10. Mr J.A. Athula
Assistant Director/NAQDA
No. 41/1, New parliament Road
071 44 81555
94 11 278 6495 / 278 6677 (office)
0112414700 (res)
94 11 278 6493 (fax)
athulaaja@yahoo.com

11. Mr S.A.M. Azmy
Head/Environmental Studies Division,
National Aquatic Resources Research and Development Agency (NARA)
Crow Island, Mattakkuliya, Colombo 15, SRI LANKA.
0094-11-2521009/0094-11-2521000/6/0094-777-368638
azmyahamed@yahoo.com, azmy@nara.ac.lk
www.nara.ac.lk

12. Mr Sunil Maithripala
Assistant Director/EIA
Central Environment Authority
Colombo, Sri Lanka
071 8682712
94 11 2872263 (office)
maithri@cea.lk

13. Dr. Yasoda Hirimuthugoda
Head of the Dept/ Dept of Animal Science, Faculty of Agriculture,
University of Ruhuna, Mapalana, Kamburupitiya
Mobile.0718601903
Fax- 041-2292384

14. Mr. D. Hettiarachchi
Director (Env. & Landscape)
Ministry of Defense & Urban Development,

Urban Development, Authority, 6th & 7th Floors, Sethsiripaya, Battaramulla, Sri Lanka
072 522 7315
94 11 2875916 20 (office)
94 11 2850070 (res)
94 11 287 8687 / 2883670
enscapeuda@gmail.com

15. Mr. D S P Kuruppuarachchi
Asst FAO Representative
FAO Colombo Office
0773659055
Premalal.kuruppuarachchi@fao.org

16. Ms Christina Semasinghe, research intern, IWMI
International Water Management Institute
P. O. Box 2075, Colombo, Sri Lanka.
127, Sunil Mawatha, Pelawatte, Battaramulla, Sri Lanka
Telephone: +94-11 2880000, 2784080
Fax: +94-11 2786854
Email: iwmi [at] cgiar.org
http://www.iwmi.cgiar.org/about/contacts/

Resource Persons for the Technical Session

17. Javier Mateo-Sagasta
Senior researcher (water quality and safe reuse).
International Water Management Institute (IWMI)
PO Box 2075, Colombo
Sri Lanka
Phone: +94 1 867 404
Fax: +94 1 866 854
Email: j.mateo-sagasta@cgiar.org

18. Dr. Ajit Kumar Pattnaik, IFS,
Chief Executive,
Chilika Development Authority
Plot No. C-11 , BJB Nagar
Bhubaneswar - 751014
Odisha , India
Phone: 91(674)2434044
Fax: 91(674)2434485
Email: chilika@chilika.com
http://www.chilika.com/contact_us.htm

19. Dr (Mrs) Banduni Attapattu
Senior Lecturer/Department of Civil Engineering
The Open University, Sri Lanka
Phone: 0777577321
bandunee@yahoo.com

20. Dr Anil Premaratne
Director General/ Coast Conservation Department
4th Floor, Ministry of Fisheries Building,
New Secretariat,
Maligawatta, Maradana, Colombo 10
+94 11 244 9754
+94 11 243 8005
premaratnaanil@yahoo.com

21. Dr. Anjan Datta
House B173 5th Floor
Road 23. New DOHS, Mohakhali
Dhaka 1206, Bangladesh
anjandatta@gmail.com

22. Prof. Ivan Silva
77/2, Hettiyawatte, Elapitiwela, Ragama
0719513809
Telefax; +94 11 2955 844
Mobile: +94 77 4640 918

Indian Nitrogen Group - Consultant for the Report

23. Dr. T.K. Adhya, FNA, FNASc, FNAAS, FAS&T, FAMI
Professor, School of Biotechnology
KIIT University/ Bhubaneswar - 751024, Odisha, India
Phone (O) : +91-674-2725466Fax : +91-674-2725732Mobile : +91-943-730-4299
adhyas@yahoo.com

24. Dr. N. Raghuram
Associate Professor/School of Biotechnology,
GGS Indraprastha University,
Sector 16C, Dwarka, New Delhi - 110078, INDIA.Email: raghuram98@hotmail.com,
raghuram@ipu.ac.in
www.ipu.ac.in/usbt/btraghu.htmPhone: (91-11) 25302308

Workshop Facilitator

25. Dr. Sevvandi Jayakody Senior Lecturer/Department of Aquaculture & Fisheries
Wayamba University of Sri Lanka
Tel: 0094 (0)31 2299874; 0094 (0)77 2036138

Fax: 0094 (0)31 2299870

BOBLME Project

26. Dr Rudolf Hermes
Chief Technical Advisor/Bay of Bengal Large Marine Ecosystem Project
C/- Andaman Sea Fisheries Research Development Center
77 Moo 7 Sakdidej Rd, Makham Bay, T.Vichit
A.Muang Phuket 83000, Thailand

SACEP Secretariat

27. Mr S.M.D.P. Anura Jayatilake
Director General
South Asia Co-operative Environment Programme
#10, Anderson Road, Off Dickman's Road, Colombo 05.
Office: 94 11 258 9376
Mobile: 0777 363 133
Fax: 94 11 258 9369
anura.jayatilake@sacep.org

28. Mr W.K. Rathnadeera
Senior Programme Officer
South Asia Co-operative Environment Programme
#10, Anderson Road, Off Dickman's Road, Colombo 05.
Office: 94 11 2500546
Fax: 94 11 258 9369
rathnadeera.wk@sacep.org

29. Ms Nishanthi M.P. Perera
Programme Officer
South Asia Co-operative Environment Programme
#10, Anderson Road, Off Dickman's Road, Colombo 05.
Office: 94 11 25362851
Fax: 94 11 258 9369
nishanthi.perera@sacep.org

30. Ms Priyankari Alexander
Programme Officer
South Asia Co-operative Environment Programme
#10, Anderson Road, Off Dickman's Road, Colombo 05.
Office: 94 11 2552761
Fax: 94 11 258 9369
priyankari.alexander@sacep.org

Annex 4.3 Inauguration Ceremony Speeches

- **Mr S.M.D.P. Anura Jayatilake, Director General/SACEP**

Degradation of marine environment resulting from land based activities is a current global concern and in order to address this emerging threat the Global Programme of Action for the Protection of the Marine Environment from Land based activities was adopted at an Intergovernmental conference held in Washington DC in 1995. The GPA was designed to assist states in taking actions individually or jointly within their respective policies, priorities and resources, which will lead to the prevention, reduction, control and or elimination of the degradation of the marine environment as well as its recovery from the impacts of land based activities.

SACEP as the secretariat for the South Asian Seas programme has been actively involved in promoting GPA activities within the region as one of the four priority areas identified under the South Asian Seas Action Plan. We in 1997 organized the first regional workshop, where the development of National Action Plans to implement GPA was discussed and promoted.
The SAS Region includes the seas bordering Bangladesh, India, Maldives, Pakistan, and Sri Lanka and comprises the Northern part of the Indian Ocean, along with parts of the Bay of Bengal and the Arabian Sea. The region has some of the largest biologically rich marine ecosystems, like the Gulf of Mannar, coral atolls of the Maldives and India, coastal lagoons like Chilika and Puttalam, vast mudflats of the Gulf of Kutch and Jaffna, and the mangroves such as Sundarbans. The survival of this rich biological wealth is threatened by many factors including anthropogenic actions.

The countries constituting the SAS Region have almost a fifth of the world's total population. High population density, low income, low development indicators, and high dependence upon natural resources for livelihood characterize all these countries. The major sources of coastal and marine pollution originating from land vary among the SAS countries, which show great disparity in size and demography. The nature and intensity of development activities, human population size, income level, and state and type of industry and agriculture are among the factors contributing to each country's unique pollution problems.

The organization of this workshop had bit of history. SACEP participated at a regional meeting organized by BOBLME project to share experiences in addressing Land-based sources of Marine Pollution, in relation to development of a Regional Strategic Action Plan for the countries along the Bay of Bengal that was held in Phuket, Thailand, in June 2012. At this meeting SACEP, as the Secretariat for the South Asian Seas Programme, was request to develop and submit a project proposal to BOBLME, which will address mitigating nutrient loading to the marine environment.
To address the above request a project titled "Controlling Nutrient Loading and Eutrophication of Coastal Waters of the South Asian Seas Region" was initiated by SACEP by signing a Small Scale agreement with FAO/ Bay of Bengal Large Marine Ecosystem Project. Although Pakistan is not The main expected output of the project is to imitation of a process in developing

regional/national level dialogue to address currently unsustainable nutrient management practices to reduce environmental impacts.
In this regard a scoping study has been undertaken by a group of consultants- the Indian Nitrogen Group A two day regional workshop is being organized to validate the scoping study as well as to share experiences and lesions learned in addressing the issue.

We know that development of nutrient reduction policies and effective mitigation strategies also requires widely applicable, quantitative relationships between nutrient loading and coastal ecosystem effects. While there is considerable information on nutrient sources and coastal impacts, this information is often much dispersed and has not yet been compiled into a consistent database so that nutrient sources in specific LMEs can be linked to impacts in their associated coastal system. This is a critical next step in order for a toolbox to be developed so that effective policy measures can be formulated and measures taken, and for the outcomes of those policies and measures to be evaluated.

Many technical and political options are available to reduce fertilizer use, decrease nutrient run-off from livestock waste, decrease NOx emissions from fossil fuel burning, and enhance sewage treatment. The fact that many of these tools have not yet been implemented on a significant scale suggests that additional technological options and new policy approaches are needed. In addition, policy approaches to address non-point source pollution are often non existent or very limited. To ensure that the science used to develop these technologies and polices is sound and complete, existing data on nutrient sources, mobilisation, distribution, and effects need to be assessed. An approach is needed such as that being developed in GEF-sponsored LME programs and as promoted by the International Nitrogen Initiative (INI: INitrogen.org) where all stakeholders – including scientists, policy makers and private sector leaders – work together to develop a better understanding of the issues and to identify and implement workable solutions.

- **Dr Rudolf Hermes, Chief Technical Advisor/Bay of Bengal Large Marine Ecosystem Project**

It is my privilege and pleasure to great you all on the occasion of the inauguration ceremony of this sub-regional workshop. I am conveying also the greetings and best wishes of the Bay of Bengal Large Marine Ecosystem (BOBLME) Project Regional Coordinator, Dr. Chris O'Brien, who is currently attending a project activity in Bangkok, Thailand.

I will have a chance to introduce BOBLME a little later to you; therefore at this moment I want just to state that I am particularly pleased to be able to participate today and tomorrow in our endeavor to validate the Nutrient Pollution Scoping Study.

BOBLME is a regional project of the Food and Agriculture Organisation of the United Nations, working with eight countries of the LME. FAO has developed the Code of Conduct for Responsible Fisheries (CCRF) promoting sustainable fisheries, and more recently, the Ecosystem Approach to Fisheries (EAF): seeking a balance between ecological well-being and social wellbeing (through good governance), emphasizing the “human dimension” of fisheries. Ecosystem health is a key module for all LME projects, and for the EAF, and hence this cooperation on Nutrient Pollution.

The current work, carried out in collaboration with the South Asia Cooperative Environment Programme (SACEP), is among the key partnerships in the field of environment that BOBLME has entered into; others have been the work with UNEP-GPA, universities, and the International Geosphere Biosphere Programme (likewise on nutrients).

You could argue that BOBLME, funded by the Global Environment Facility (GEF), Norway (NORAD) and Sweden (SIDA) is a fisheries project with an environmental focus, but also the opposite holds true. The BOBLME Project addresses major fisheries and environmental issues which are shared by all 8 countries (also called ‘transboundary’ issues):

- Overexploitation of marine living resources
- Degradation of mangroves, coral reefs and seagrasses
- Pollution and water quality.

Not all activities are carried out in all 8 countries, and this sub-regional activity is such a case where it makes sense to work on a smaller set of countries (and even welcoming an additional country, Pakistan), into the cooperation. Flexibility is the key here, and openness for transboundary collaboration and partnerships. The Project works towards the common vision of the BOBLME countries: “A healthy ecosystem and sustainable use of marine living resources for the benefit of the countries of the Bay of Bengal Large Marine Ecosystem”, and the region’s shared desires:

- Enough fish for future generations;
- Healthy coastal and near-shore marine habitats;
- Reduced pollution from agriculture, industry and large coastal cities;
- Coastal communities resilient to the impacts of climate change;
- Stakeholders working together for the common good.

In closing I want to summarize that our workshop today and tomorrow highlights and underlines the importance of three major concerns of the BOBLME Project, namely
Regional cooperation, capacity development and knowledge management. These are al the cross-cutting themes of the BOBLME Project (aside from all the thematic work on fisheries (hilsa shad), habitats (coral reefs, seagrass beds), and pollution (water quality, ecosystem health).

Regional Cooperation is also in fact happening here and now: a regional inter-governmental organization linked to the Regional Seas Programme of UNEP and the SAARC, partnering with a UN-FAO Field Project, and a range of other partners from the academe and five South Asian countries.

It is also an example of capacity development, as we will be experiencing and practicing in this workshop an ecosystem approach to nutrient pollution management, a variation of the EAF theme, and very much in line to the commitment of all UN member countries to promote the ecosystem approach.

This brings us to the third cross-cutting theme: Knowledge management. We will learn from the presentation of countries and organization on current status on mitigating nutrient pollution, we will validate the scoping study – all of these increasing the unde3rstanding and the knowledge base with the aim to addressing the problem of nutrient pollution.

In closing, I want to thank our partners SACEP for arranging and hosting this important workshop. I wish us all good success and that the workshop may achieve objectives at all three levels: generating information useful for management, improving skills and knowledge and enhancing capacity, and practicing regional cooperation.

Ladies and Gentlemen, thank you for your attention and a good day to all.

- **Hon Susil Premajayantha MP, Minister of Environment and Renewable Energy/Government of Sri Lanka**

Ayubowan and Good Morning,
Excellency's,
Distinguished Delegates from South Asian Countries
Ladies and Gentlemen,

It is my great pleasure to participate at the inauguration of this South Asia Regional Workshop on Nutrient and Pollution on Coastal and Marine Resources of the South Asian Seas.

As you may be aware, land-based nutrients such as nitrogen and phosphorus inputs to coastal systems around the world have markedly increased primarily due to the production of food and energy to support the growing population of over 6 billion people. The resulting nutrient enrichment has contributed to coastal eutrophication, degradation of water quality and coastal habitats.

As an Island state, protecting the marine environment is one of the major challenges faced by Sri Lanka on the account of its immense value, both in the form of food security and livelihoods of our people. Yet the biologically rich coastal and marine environment is now being rapidly degraded leading to loss of ecosystem services provided by them leading to high economic loses.

The problem of water pollution in Sri Lanka's coastal region has been growing over the past decades, as high pollution loads including nutrients are generated due to development activities, tourism and fishing industries, urbanization, human settlements and agricultural practices located within as well as out of the coastal region.
As such the need for a more effective marine water pollution control system is a primary concern. Actions are required to control and mitigate the impacts caused by different sectors

of development including sewage, effluents from industries and aquaculture, as well as undesirable runoffs from agriculture and livestock.

Though these concerns seem to be national issues, they have a regional or transboundary flavor. You may agree with me that, solving these problems at national level is not sufficient to protect our coastal and marine resources and it had to be addressed regionally.

In last December, in Islamabad, Pakistan, during the last Governing Council Meeting of South Asia Co-operative Environment Programme (SACEP) and the Inter Ministerial Meeting of the South Asian Seas Programme, We the Environment Ministers of the South Asian region decided that these type of regional and transboundary issues should be handled and coordinated by South Asia co-operative Environment Programme, and SACEP was entrusted to develop suitable programmes to address these concerns.

We, the South Asian Environment Ministers entrusted the following areas to be handled by SACEP

- Control of Pollution of Coastal and Marine Resources by land based sources.
- Management of Ships Ballast Water to protect our coastal and marine resources from ships ballasts invasive or alien species
- Development of a South Asia Regional Oil Spill Contingency Plan and Response which has a direct impact of our coastal and marine resources
- Development of a South Asia Regional Marine Biodiversity Strategy and Action Plan

In this regard, SACEP with the assistance of International Maritime Organization (IMO), United Nations Environment Programme (UNEP), and FAO/BOBLME Project has developed programmes to achieve the above objectives.

In February, this year in Colombo, SACEP was able to hold two regional workshops related to ballast water management and South Asia Oil Spill Contingency and to initiate related regional processes. The actions at national level have already begun by the respective national agencies. This workshop will also initiate another process which is in line with our thinking identified in Islamabad.

Distinguished Delegates, Ladies and Gentlemen,

The Government of Sri Lanka has embarked on a rapid development agenda after successful eradication of terrorism in 2010, covering in all the sectors of economy namely tourism, urban and infrastructure development , industrial development, aviation and naval development ; new International Airport at Mattala, Magampura Seaport at Hambantota are to name a few.

In this development scenario, Government of Sri Lanka has also acted towards maintaining the good health and productivity of the marine environment through several legislative enactments, policies, programmers and projects. Some of the main legislative enactments and related agencies are

- The Marine Environment Protection Authority established under the Marine Environment Protection Act, for the protection of the marine environment

- The Central Environmental Authority established under the National Environment Act for the protection, enhancement and management of the environment of the country
- The Coast Conservation Department established to protect and preserve the coastal zone
- The Urban Development Authority established for the planning and management of development activities within the country.

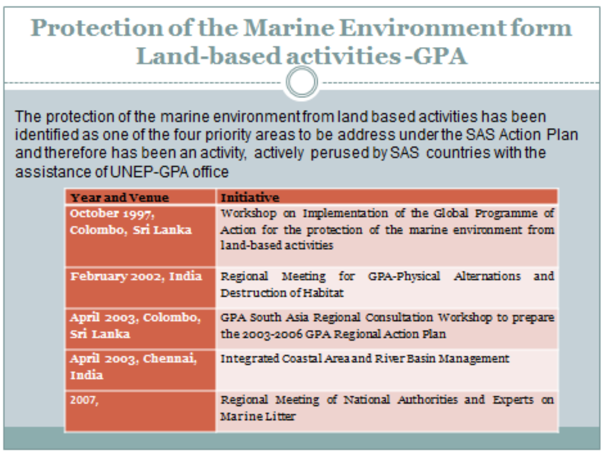
Ladies and Gentlemen
It is with due regard, I take this opportunity to express my deep appreciation to South Asia Cooperative Environment Programme (SACEP) as well as BOBLME project for initiating this process on pollution on coastal and marine resources of South Asia and I hope that during the deliberation of the workshop you will be able to develop suitable strategies and action plans to curb, minimize this problem in our seas.

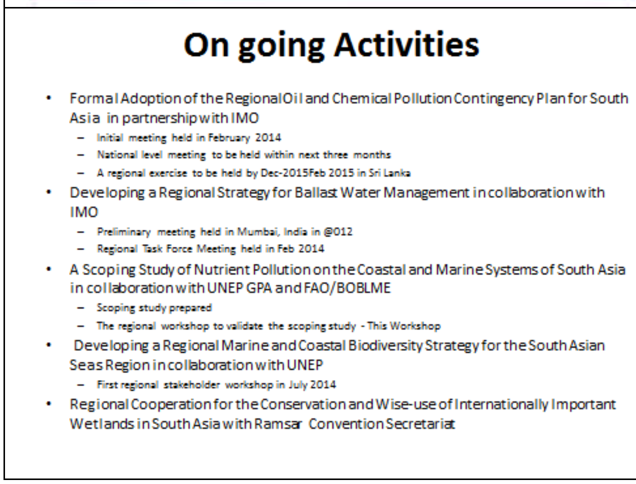
Further, on behalf of the Government of Sri Lanka I welcome all our delegates from South Asian countries, all the experts, and officials from national agencies participating in this important workshop and hope that our foreign friends would be able to see some of our scenic places during their stay in Colombo, Sri Lanka.

Thank You

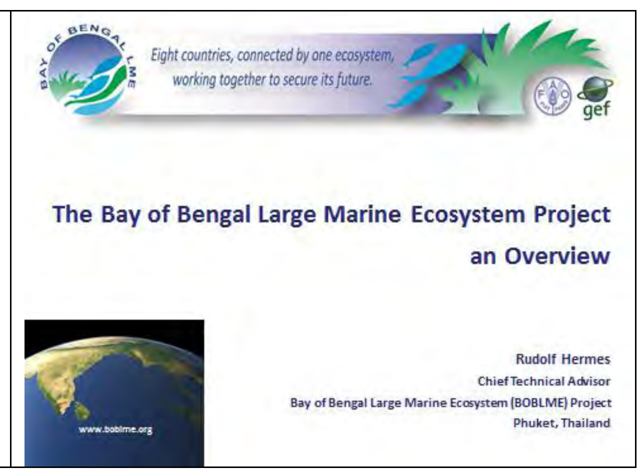
Annex 4.4: Presentations by Workshop collaborator and Countries

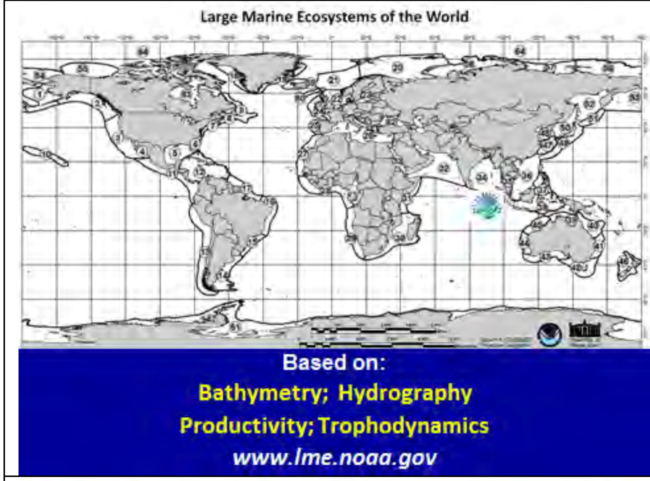
- ***SACEP's Initiatives for Addressing Marine Pollution in South Asia***

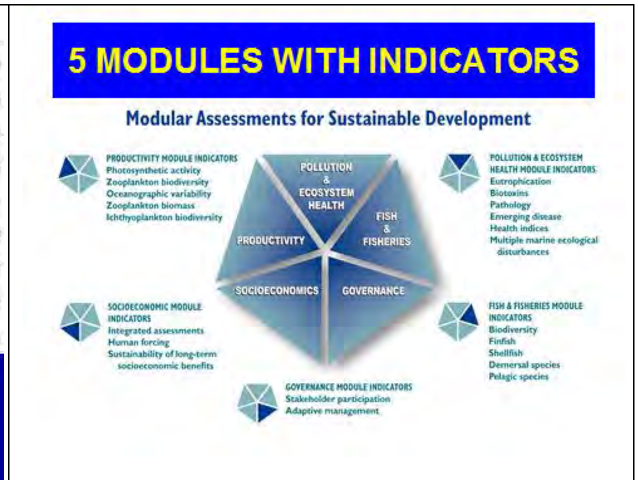


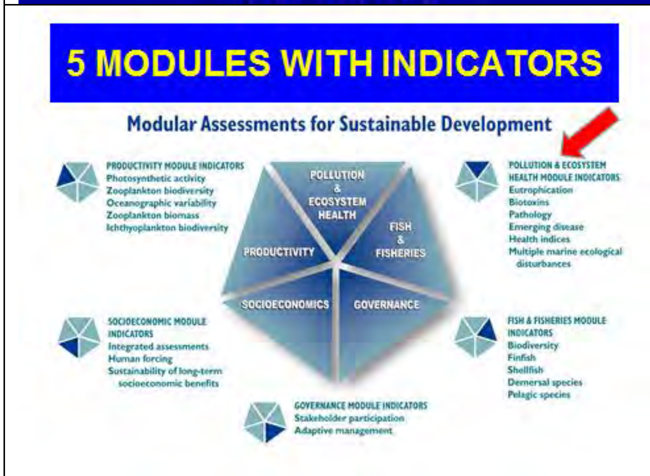


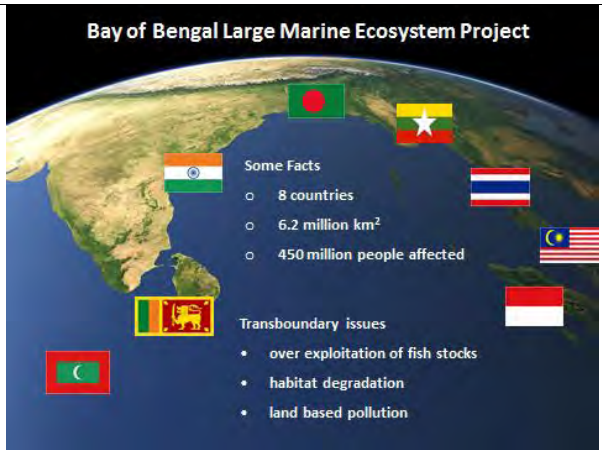
- ***The Bay of Bengal Large Marine Ecosystem Project: an Overview***



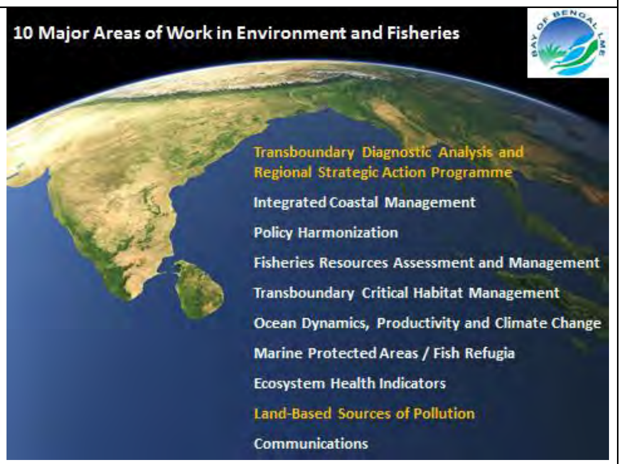

Large Marine Ecosystems of the World
Based on:
Bathymetry; Hydrography
Productivity; Trophodynamics
www.lme.noaa.gov


5 MODULES WITH INDICATORS
Modular Assessments for Sustainable Development
PRODUCTIVITY MODULE INDICATORS
Photosynthetic activity
Zooplankton biodiversity
Oceanographic variability
Zooplankton biomass
Ichthyoplankton biodiversity
POLLUTION & ECOSYSTEM HEALTH
FISH & FISHERIES
PRODUCTIVITY
SOCIOECONOMICS
GOVERNANCE
POLLUTION & ECOSYSTEM HEALTH MODULE INDICATORS
Eutrophication
Biotoxins
Pathology
Emerging disease
Health indices
Multiple marine ecological disturbances
SOCIOECONOMIC MODULE INDICATORS
Integrated assessments
Human forcing
Sustainability of long-term socioeconomic benefits
FISH & FISHERIES MODULE INDICATORS
Biodiversity
Finfish
Shellfish
Demersal species
Pelagic species
GOVERNANCE MODULE INDICATORS
Stakeholder participation
Adaptive management


5 MODULES WITH INDICATORS
Modular Assessments for Sustainable Development
PRODUCTIVITY MODULE INDICATORS
Photosynthetic activity
Zooplankton biodiversity
Oceanographic variability
Zooplankton biomass
Ichthyoplankton biodiversity
POLLUTION & ECOSYSTEM HEALTH
FISH & FISHERIES
PRODUCTIVITY
SOCIOECONOMICS
GOVERNANCE
POLLUTION & ECOSYSTEM HEALTH MODULE INDICATORS
Eutrophication
Biotoxins
Pathology
Emerging disease
Health indices
Multiple marine ecological disturbances
SOCIOECONOMIC MODULE INDICATORS
Integrated assessments
Human forcing
Sustainability of long-term socioeconomic benefits
FISH & FISHERIES MODULE INDICATORS
Biodiversity
Finfish
Shellfish
Demersal species
Pelagic species
GOVERNANCE MODULE INDICATORS
Stakeholder participation
Adaptive management


Bay of Bengal Large Marine Ecosystem Project
Some Facts
8 countries
6.2 million km²
450 million people affected
Transboundary issues
over exploitation of fish stocks
habitat degradation
land based pollution


BAY OF BENGAL LME
Eight countries, connected by one ecosystem, working together to secure its future.
gef
Norad
SWEDEN
NOAA


10 Major Areas of Work in Environment and Fisheries
BAY OF BENGAL LME
Transboundary Diagnostic Analysis and Regional Strategic Action Programme
Integrated Coastal Management
Policy Harmonization
Fisheries Resources Assessment and Management
Transboundary Critical Habitat Management
Ocean Dynamics, Productivity and Climate Change
Marine Protected Areas / Fish Refugia
Ecosystem Health Indicators
Land-Based Sources of Pollution
Communications

Two major outputs:

Transboundary Diagnostic Analysis (TDA)

A report on the major transboundary issues and their causes

Strategic Action Programme (SAP)

A (strategic action) plan for addressing the major transboundary issues and their causes

Expected Outcomes of the BOBLME Project

- Improved governance of fisheries and environment
- More effective regional cooperation
- An enhanced knowledge base
- Capacity development
- Implementation of the Ecosystem Approach to Fisheries (EAF) management
  - ➤ Healthier habitats and ecosystems, sustainable fisheries

DIN inputs (tons N/y) to LMEs from land-based sources predicted by the NEWS DIN

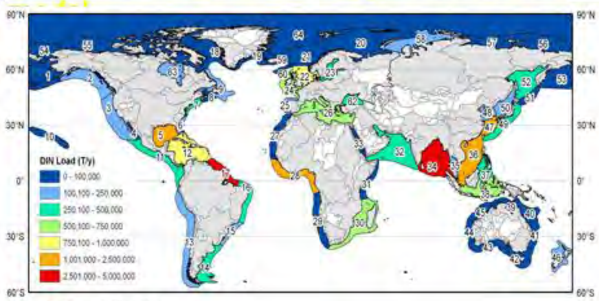


Figure Seitzinger and Lee, 2008.

Strategic Action Programme (SAP): BOBLME Phase 2

Vision

"A healthy ecosystem and sustainable use of marine resources for the benefit of the countries of the BOBLME"

Theme 3: Pollution and Water Quality

EcoQO3: Coastal and marine pollution and water quality are controlled to meet agreed standards for human and ecosystem health

Transboundary and national actions will be undertaken in the areas of:

Institutional arrangements, Legal and policy reforms;
Management measures;
Knowledge strengthening, Awareness and communication;
Human capacity development

Objectives

1. Reduce or minimize the discharge of untreated sewage and waste water into river, coastal and marine waters
2. Reduce and minimize solid waste and marine litter
3. Reduce and control nutrient loading into coastal waters

BAY OF BENGAL LME

www.boblme.org

- ***Indian Country presentation***

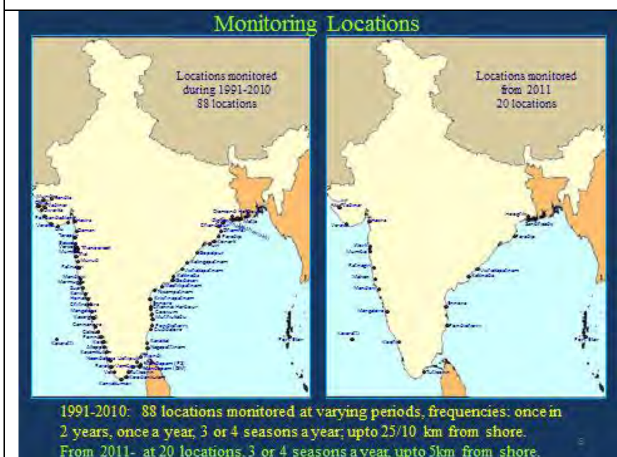
Nutrients Status in Indian coastal Waters

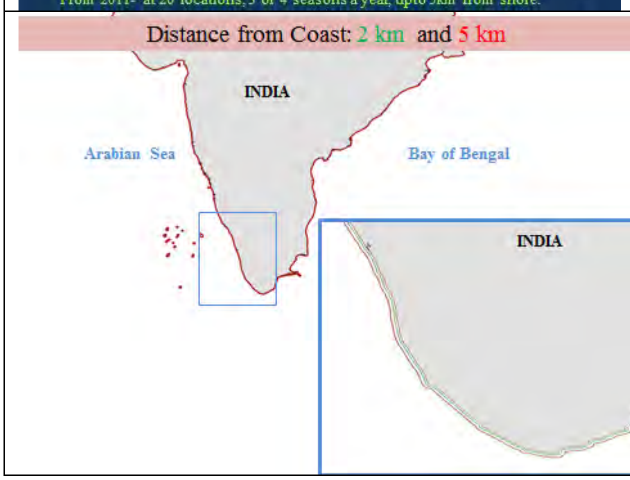
Dr.Sivaji Patra
Dr.Anil Kumar Vijayan

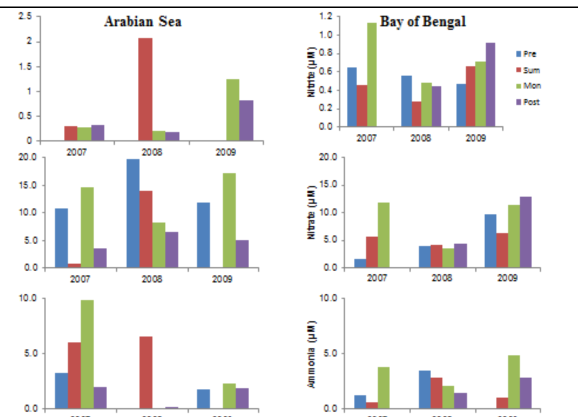
Ministry of Earth Sciences
Govt.of India
Prithvi Bhavan, IMD Campus, Opp. India Habitat Centre,
Lodi Road, New Delhi - 110003.
www.moes.gov.in

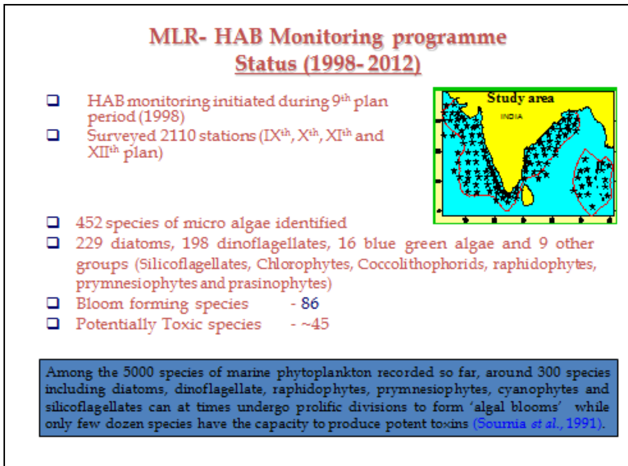
Ministry of Earth Sciences has following programme for nutrients related studies:

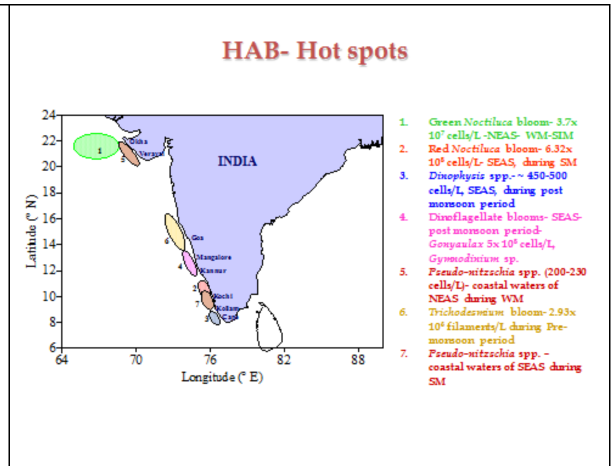
1. Coastal Ocean Monitoring and Prediction Systems (COMAPS)/Sea Water Quality Monitoring (SWQ)
2. Harmful algal blooms.
3. Ecosystem Modeling.

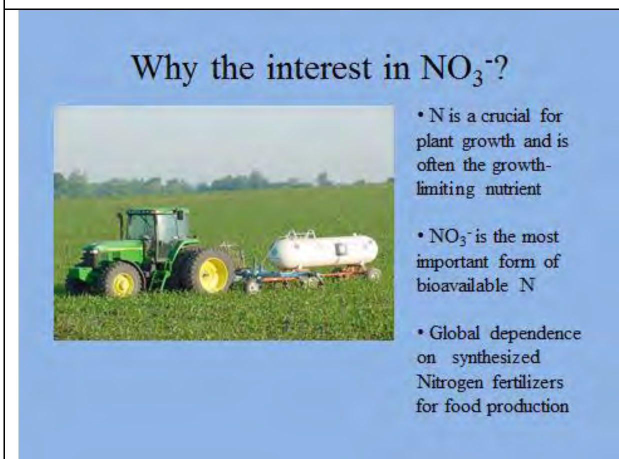


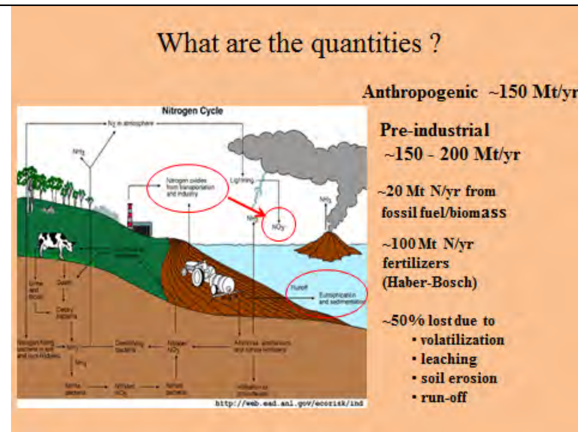


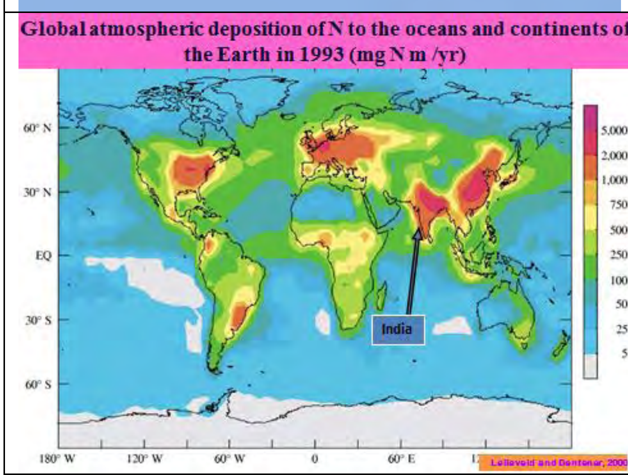


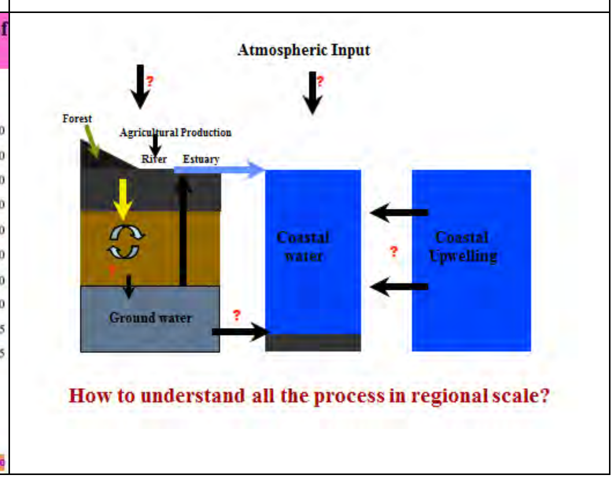

MLR- HAB Monitoring programme
Status (1998- 2012)
HAB monitoring initiated during 9th plan period (1998)
Surveyed 2110 stations (IXth, Xth, XIth and XIIth plan)
Study area
INDIA
452 species of micro algae identified
229 diatoms, 198 dinoflagellates, 16 blue green algae and 9 other groups (Silicoflagellates, Chlorophytes, Coccolithophorids, raphidophytes, prymnesiophytes and prasinophytes)
Bloom forming species - 86
Potentially Toxic species - ~45
Among the 5000 species of marine phytoplankton recorded so far, around 300 species including diatoms, dinoflagellate, raphidophytes, prymnesiophytes, cyanophytes and silicoflagellates can at times undergo prolific divisions to form 'algal blooms' while only few dozen species have the capacity to produce potent toxins (Sournia et al., 1991).

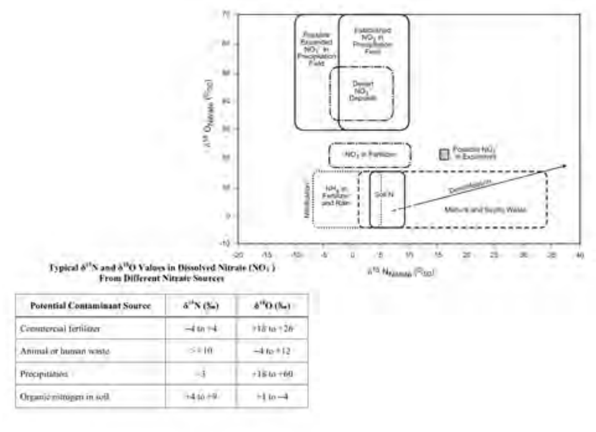

HAB- Hot spots
INDIA
Latitude (° N)
Longitude (° E)
1. Green Noctiluca bloom- 3.7x 10⁷ cells/L -NEAS- WM-SIM
2. Red Noctiluca bloom- 6.32x 10⁶ cells/L- SEAS, during SM
3. Dinophysis spp.- ~ 450-500 cells/L, SEAS, during post monsoon period
4. Dinoflagellate blooms- SEAS- post monsoon period- Gonyaulax 5x 10⁶ cells/L, Gymnodinium sp.
5. Pseudo-nitzschia spp. (200-230 cells/L)- coastal waters of NEAS during WM
6. Trichodesmium bloom- 2.93x 10⁶ filaments/L during Pre-monsoon period
7. Pseudo-nitzschia spp. - coastal waters of SEAS during SM

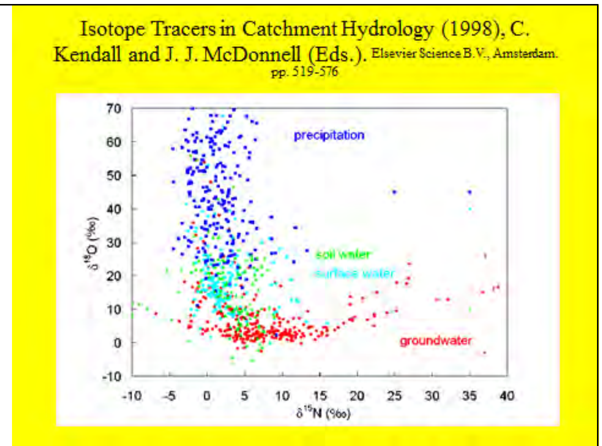

Why the interest in NO3-?
• N is a crucial for plant growth and is often the growth-limiting nutrient
• NO3- is the most important form of bioavailable N
• Global dependence on synthesized Nitrogen fertilizers for food production


What are the quantities ?
Anthropogenic ~150 Mt/yr
Nitrogen Cycle
Pre-industrial ~150 - 200 Mt/yr
~20 Mt N/yr from fossil fuel/biomass
~100 Mt N/yr fertilizers (Haber-Bosch)
~50% lost due to
• volatilization
• leaching
• soil erosion
• run-off

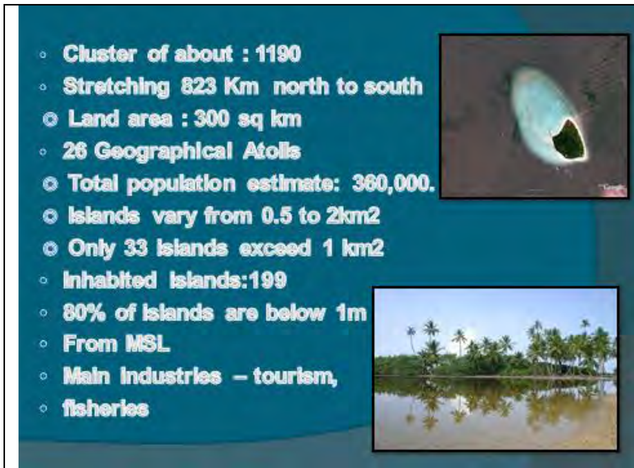

Global atmospheric deposition of N to the oceans and continents of the Earth in 1993 (mg N m /yr)
India
Lelieveld and Dentener, 2000

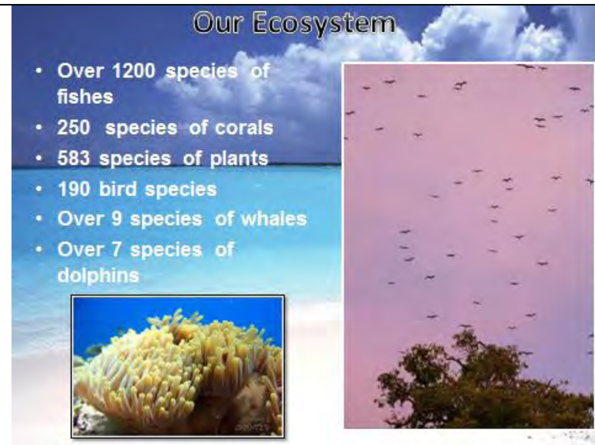

Atmospheric Input
Forest
Agricultural Production
River
Estuary
Coastal water
Coastal Upwelling
Ground water
How to understand all the process in regional scale?





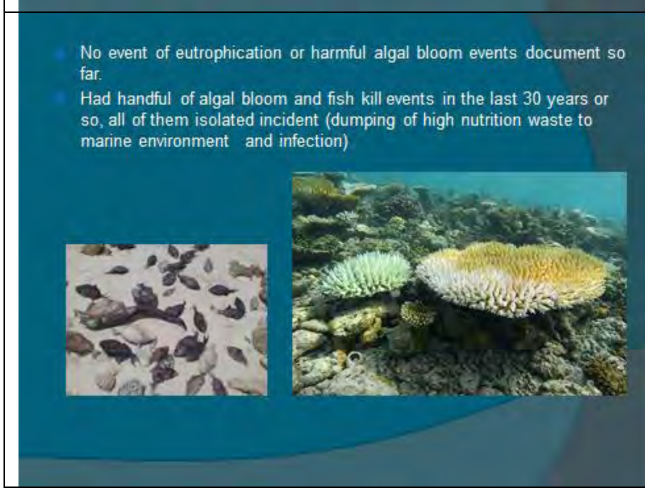
- ***Maldives Country presentation***


Cluster of about : 1190
Stretching 823 Km north to south
Land area : 300 sq km
26 Geographical Atolls
Total population estimate: 360,000.
Islands vary from 0.5 to 2km2
Only 33 Islands exceed 1 km2
Inhabited Islands:199
80% of Islands are below 1m
From MSL
Main Industries – tourism,
fisheries


Our Ecosystem
Over 1200 species of fishes
250 species of corals
583 species of plants
190 bird species
Over 9 species of whales
Over 7 species of dolphins

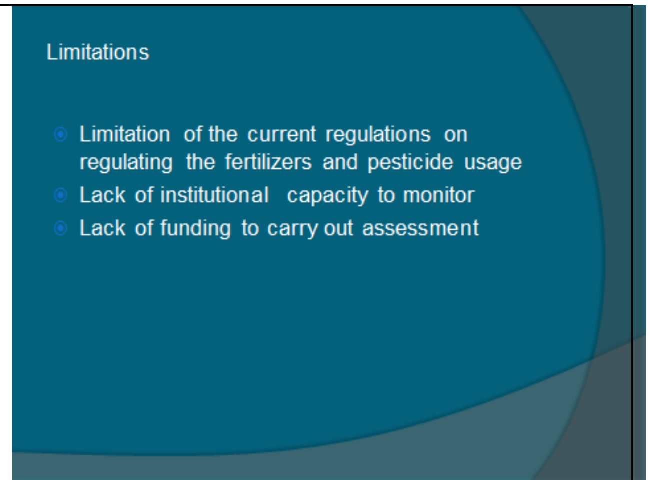

Ground Situation
Point sources
Out of 199 inhabited islands only 35 islands have sewerage system, out of 35 none of the islands have treatment plant
Raw sewage is discharge directly to marine environment
Rest of islands use underground septic tanks
Its mandatory that all the resorts to have sewerage system and treatment plant
Remaining water discharge to marine environment or used in irrigation


Non Point sources
Waste management facilities on the beach
Due to lack of maintenance and erosion of coastal shoreline much of the waste is carried into the sea
Run off from mention waste management facilities during raining season and floods
Illegal dumping of waste and waste

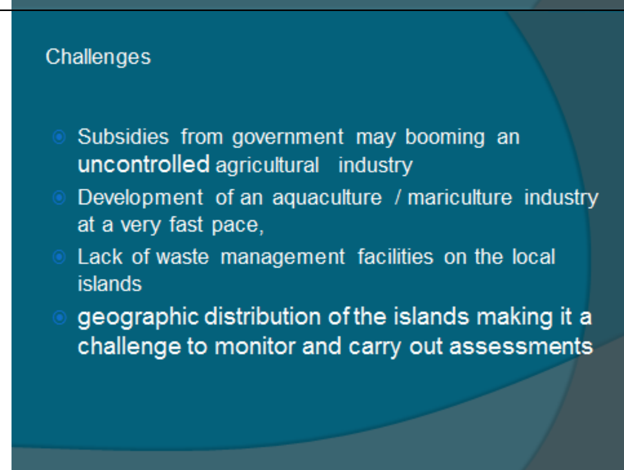

No event of eutrophication or harmful algal bloom events document so far.
Had handful of algal bloom and fish kill events in the last 30 years or so, all of them isolated incident (dumping of high nutrition waste to marine environment and infection)


Regulations
Maldives Environment Protection &Preservation Act of 1993
Environment Impact Regulation 2012
Regulation on Environmental Liabilities 2011
Waste management regulation 2014


key stakeholders
Ministry of Environment and Energy
Environment Protection Agency
Ministry of Fisheries and Agriculture
Island councils and Atoll councils
Local NGOs
Farmers
Tourism industry
Fishing industry


Limitations
Limitation of the current regulations on regulating the fertilizers and pesticide usage
Lack of institutional capacity to monitor
Lack of funding to carry out assessment


Opportunities
Strong waste management regulation coming into force in June 2014
Environment Impact Regulation 2012
42 Protected Areas


Challenges
Subsidies from government may booming an uncontrolled agricultural industry
Development of an aquaculture / mariculture industry at a very fast pace,
Lack of waste management facilities on the local islands
geographic distribution of the islands making it a challenge to monitor and carry out assessments

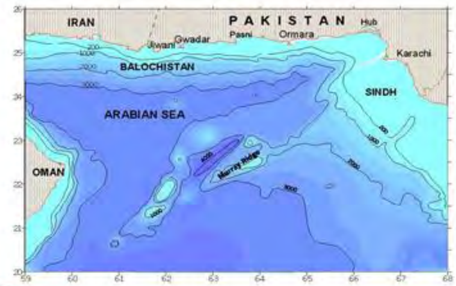

photography by: SHAN
THANK YOU

- **Pakistan Country Presentation**

Status of Nutrient Pollution in the coastal areas of Pakistan

Ghazala Siddiqui
Centre of Excellence in Marine Biology, University of Karachi, Pakistan

- Coastline of Pakistan
  - Total=1050 km
  - Sindh= 250 km   Balochistan= 800 km



Creeks on Sindh coast

Indus Delta

- Indus Delta seventh largest in the world.
- Area of 600,000 ha
- 20 major and hundreds of small creeks.
- Highest river discharge is in July due to snow melt in Himalaya.
  - 80% in May to October.
- Tidal creeks are wide and often >70 km long and make up 27% of the delta.
- Main monthly spring tide range from 3.4 to 3.9.
- Creeks are generally well mixed.
- Large part of the delta is a negative estuary since evapotranspiration (> 2000 mm/yr) is greater than rainfall (~ 200 mm/yr

(Schubel, 1984, Harrison et al., 1997)

Tidal channels

- High concentration of nutrients in summer (SW monsoon season)
- In SW monsoon average wind speed is 8-9 m/s.
- Many of the tidal channels lie along SW-NE axis and they are 3- to 70 km long.
- As a result there is a considerable fetch and water is pushed up the tidal channels by the SW wind
- Maximum tidal height occurs in July which coincides with the maximum wind speed and result in maximum inundation

(Harrison, 1997)

Mangroves

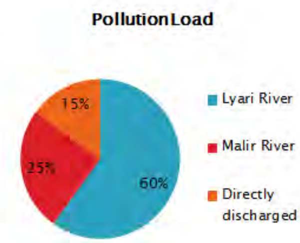
- The area of mangrove cover in the active Indus Delta was estimated to be about 250,000 ha some decades ago (Khan, 1966, Mirza et al, 1973).
- Due to shift of delta towards southerly course started deteriorating
- These mangroves further degraded due to:
  - cutting
  - browsing
  - reduced silt laden river water.
- These forests recessed to about 160,000 ha (Kela, 1999, IUCN, 2005).

Suspended matter and Primary productivity in creeks

- Suspended matter in the Creeks in the vicinity of Karachi ranges from 25 to 178 ppm
- Average primary productivity in Creeks is 0.238 - 0.475 g C/m3/day.

(Harrison et al., 1994, Zaqoot, 2000)

- Pollution load which mostly originate in creeks (Korangi, Phitti Kadiro and Gharo creeks) in the southeast of Karachi as a result of discharge of domestic and industrial wastes



- Pollution load: creeks and coastal area surrounding Karachi.
- As a result of anthropogenic activities:
  - Municipal and industrial effluents
- Effluents of more than 6000 industries units located in six big industrial estates
- 300 MGD municipal wastewater is discharged into Karachi coastal waters through Malir and Layari rivers (WWF, 2002).

- BOD load of about 1,500 tons/day is added into sea by industries in addition to inorganic pollutants (ADB, 2007).
- The Layari River discharges:
  - Solid nitrogen: 130,000 tons/yr
  - Organic matter: 160,000 tons/yr
  - Nitrogen compounds: 800 tons/yr
  - Phosphate compounds: 90 tons/yr
  - suspended solid 12,000 tons/yr

into Manora Channel (JICA, 2007).

Sites receiving large quantities of nutrients

- Karachi Harbour
- Gizri creek
- Korangi creek
- Gharo creek
- Receive large quantities of nutrients as part of the liquid waste and garbage being disposed of in these creeks receives high nutrient loadings.
- Higher concentrations of nutrients result in overproduction and utilization of DO.

- The presence of seaweeds in the mangrove areas of Karachi is associated with the high loads of nutrients from industrial and domestic sewage being drained in these waters (Shafeque *et al.,* 2013).
  - *Enteromorpha intestinalis,*
  - *E. clathrata*
  - *Ulva reticulata*

- **Anoxic conditions:**
  - About 40% of the bottom areas of Karachi Harbour
  - About 60% in the Gizri Creek areas (Rizvi et al. 1999).
- **Eutrophication :**
  - Conspicuous in the middle and lower parts of Gizri creek.
- **Phytoplankton blooms:**
  - Common in Korangi/Gizri creeks (Harrison, 1997) and in coastal waters adjacent to Clifton beach (Khan, 1986)
  - Dinoflagellates bloom in the waters of Sandspit beach, and Hawkesbay and along continental shelf of Pakistan (Saifullah and Chaghtai, 1990).

Location	Water Level	Average Depth (m)	PO_4-P µg/L	NO_3-N µg/L	NO_2-N µg/L
West Warf	Surface	10	10.36	3.81	2.44
	Bottom		4.28	-	-
Fish Harbour	Surface	3	23.25	0.18	0.10
	Bottom		31.25	1.83	1.11
Layari Mouth	Surface	3	4.60	1.35	0.83
	Bottom		4.70	2.01	1.28
Chari Kund	Surface	6	6.70	8.74	5.16
	Bottom		14.0	6.27	3.93
Manora Channel	Surface	11	14.05	2.05	1.02
	Bottom		6.05	6.61	4.13
Mausa Channel Near entrance	Surface	13	4.40	1.19	1.29
	Bottom		3.05	16.31	1.80

- Enrichment of nutrients particularly of inorganic phosphate over the entire harbour due to:
  - Industrial and sewage discharges
  - Leading to eutrophication in coastal areas.

Average Conc. at Clifton & DHA Beach

Sites	pH	DO (mg/l)	PO_4-P (µg/l)	NH_4-N (µg/l)	NO_2-N (µg/l)	NO_3-N (µg/l)
Keamari (Opp. Oil. Term.)	8.3-8.4	4.9-6.6	11-48	17-33	0.56-1-1	7.8-27.0
Clifton (Shirin Jinnah Colony)	8.3-8.4	5.4-9.0	12-68	31-41	1.4-4.9	25-26
Clifton Beach	8.3-8.4	4.7-6.6	11-70	59-60	3.9-50	8.4-28
Sea View	8.3-8.4	4.8-6.6	16-140	57-110	3.6-11	16-59
Gizri Creek	8.3-8.4	4.6-6.4	36-77	36-160	9.8-14	30-81
				Source	NIO Data	Archive

- The nutrient concentrations generally increase from Keamari Coast towards Gizri Creek
- The coastal waters opposite DHA beaches are very productive.
- This area is also influenced by Giziri Creek and Korangi Creek

Nara Creek, Indus Delta

(Farooqi & Valeem, 2009)

DO	10.8 - 17.1 mg/L
Ammonium salts	0.84 - 13.75 mg/L
Nitrite	0.03 - 13.3 mg/L
Nitrate	0.00 - 9.6 mg/L
Phosphate	0.00-3.42 mg/L
Chl 'a'	0.0 - 0.26 µg/L
TSL	0.01-0.26 mg/L

Primary Productivity

(Rizvi, 1999)

- Average Net Primary Production Rates:
- Isaro Creek- 43.07 mg C/m^3/hour
- Ghro Creek- 28.40 "
- Korangi Creek- 3.0 "

Change in the species composition of diatoms

- Species composition of diatoms has changed in Karachi Harbour and outside Manora Channel over last two decades and new species found in these areas (Luqman, 2005).
- In mangroves areas of Sandspit which have highly polluted waters, in these areas blooms of pennate diatoms *Naviculla cancellata* have been observed (Chagtai & Saifullah, 1992).

Policies

- National Environment Policy, 2005 (NEP-2005)
- Integrated Coastal Zone Management Plan (ICZMP) for Pakistan in 2011.

Legislations

- Pakistan Environmental Protection Ordinance, 1983
- Pakistan Environmental Protection Act, 1997
  - National Environmental Quality Standards (NEQS) (1993)
- Canal and Drainage Act (1873)
- Punjab Minor Canals Act (1905)
- Sindh Fisheries Ordinance (1980)

Major Issues

- Municipal and industrial effluent treatment and management
- Solid waste management
- Siltation
- Loss of mangrove forestation
- Formation of hypoxic zones sometimes leading to mass fish kill
- Construction of dams which has drastically cut down fresh water input in the deltaic region

Further strengthening and implementation of policies is required for:

- Sustainable nutrient management
- Industries waste management, conservation of environment, water quality waste treatment and nutrient recycling at all point sources.
- Phasing out of phosphate containing detergents and other products that tend to cause nutrient loading of the environment in general and water bodies in particular.
- Development of National Sewage plans to protect water bodies from nutrient, organic and other pollution
- Protection and management of mangrove forests

Annex 4.5. Presentation on the Zero draft by the Consultants

NUTRIENT LOADING AND EUTROPHICATION OF COASTAL WATERS OF THE SOUTH ASIAN SEAS

Adhya, T.K.*, Pathak, H., Ramesh, R., Amit Kumar, Biswas, J.C., Maniruzzaman, M., Kahlown, M.A., Nissanka, S.P., Raghuram, N. and Abrol Y.P.

*Co-Ordinator, Indian Nitrogen Group (ING-SCON), New Delhi

The five South Asian countries namely, Bangladesh, India, Maldives, Pakistan and Sri Lanka are home to:

1. About 22% of the global population,
2. With only 4.8% of the world's land mass,
3. 14% of the global arable land,
4. 2.73% of the world forest area and
5. 4% of the world's coastline.

Coastal habitats of South Asia are at a high risk of eutrophication from nutrient enrichment due to leakages from agriculture, aquaculture, sewage, industrial effluents, marine trade and transport.

South Asian Seas Region

Why addressing south Asian Seas context?

1. South Asia is bordered in the south by the Indian Ocean, in the South-east by Bay of Bengal and in the South-west by the Arabian Sea.
2. Occupying a major portion of the Indo-Malayan realm and a smaller portion of the Palaearctic realm, this region is representative of five of the fourteen major biomes demonstrating the biodiversity and vegetation patterns of the region as determined by climate, water, geology, soil and diverse topography of mountains, plateaus, dry regions, intervening structural basins, beaches, etc.

Why addressing south Asian Seas context?

3. Rapidly growing coastal population (as well as livestock) in these countries as well as growing fertilizer use is of concern.
4. Increasing reports on the number and frequency of algal blooms along the coast and concerns of development of hypoxic zones makes it imperative for efficient nutrient management in these countries.
5. More than 90 per cent of fisheries depend in one way or another on estuarine and near-shore habitats which are increasingly being impacted by nutrient over-enrichment of coastal waters.

Background

SACEP together with UNEP-GPA and BOBLME project developed the project concept "Controlling Nutrient Loading and eutrophication of Coastal Waters of the South Asian Seas Region" with the main objective of reducing and controlling nutrient loading into the coastal waters of the South Asian Seas Region through development of a regional action plan and policy forum/ framework.

Objectives for the study

The activities proposed under this initiative include:

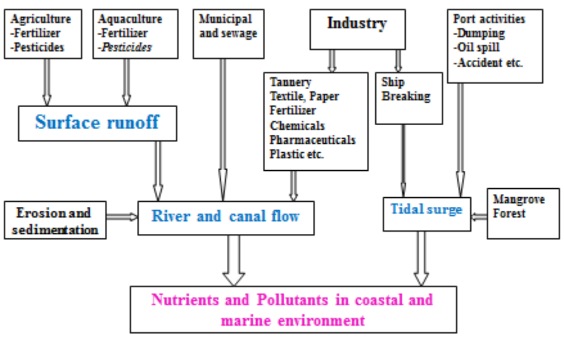
- An inventory of point/non- point sources of nutrients that end up in the coastal waters
- Estimating the impact of nutrient enrichment on coastal waters.
- Develop and undertake actions to reduce nutrient inputs to agriculture as well as remedial masseurs to over eutrophication/hypoxia conditions in identified sites.
- Development of a regional action plan and establishment of a regional policy forum to be pursued by member countries.

Objectives for the study..........

The first step in this activity was to understand

i) the spatial and temporal complexity of nutrient loading and coastal eutrophication/hypoxia
ii) the functioning of ecosystems, and socioeconomic systems.

A desk review has been undertaken for this purpose.



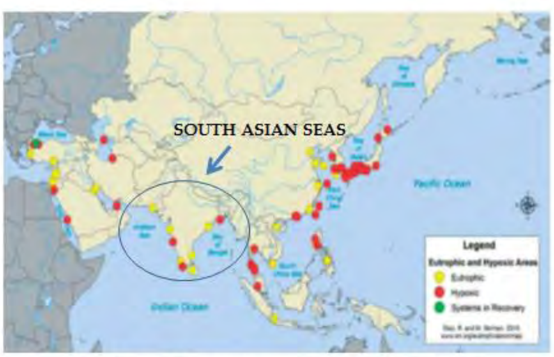
Pathways of entering nutrients and pollutants in coastal and marine environment

Eutrophication in coastal waters of South Asian Seas

Model studies indicate that globally, roughly equal amounts of reactive N reach the oceans from fertilizer, manure and atmospheric deposition with smaller fractions from sewage.

Analysis at the regional levels shows somewhat different proportions with sewage being important in south Asia. With increased urbanization, this scenario might be more acute.

This suggests the need to apply nutrient reduction strategies that best fit the nutrient profile of the region.



Eutrophic and hypoxic zones in South Asian Seas
(Source: World Resource Institute, 2102)

BANGLADESH

1. Difficult coastline with many rivers and distributaries and complex ecology.
2. Network of 230 rivers, their tributaries and distributaries make the country a virtual conglomerate of islands.
3. Coastal area divided into interior coast (23935 sq. km) and exterior coast (23266 sq. km).
4. Coastal zone land use diverse – 60% agriculture, rest for fisheries and forestry (Sunderban mangroves).
5. Nutrient pollution largely measured from rivers associated with large population centres.
6. Model studies indicate that in both lower Meghna river as well as Karnaphuli estuaries are mainly heterotrophic denitrifying systems.

Characteristics of industrial liquid wastes of Bangladesh.

Parameters (mg/L)	Textile waste water	Tannery waste water	Pulp and paper waste water	Effluent standard (GOB, 1997)
BOD	8100	36000	600	50
COD	17100	56400	1700	200
Suspended solids	15221	7498	2024	150
Nitrate	200	700	-	10
Chloride	80000	62500	5900	600
Chromium	0.47	3818	-	0.5
Sulfide	-	1500	-	1.0

Source: Unnayan Shammannay, 2003 as cited by BOBLME, 2011

INDIA

1. Long coast of 7517 km – 5423 km belongs to peninsular India, 2094 km to Andaman/Nicobar/Lakshadweep islands. Mainland coast – 43% sandy beaches, 11% rocky coast and 46% mudflats
2. Situated in between two ocean systems – Arabian sea experiences strong upwelling and have reports of natural hypoxic conditions in the western coast.
3. Reports on the eutrophication of estuaries and coastal waters are available from a few places.
4. World's largest natural hypoxic zone develops seasonally over the Western Indian sub-continental shelf, likely due to N loading

Inputs of pollutants in the coastal environment of India (deSa, 1994)

S. No.	Input / pollutant	Quantum –Annual
1	Sediments	1600 million tones
2	Industrial effluents	50 x $10^6 m^3$
3	Sewage -largely untreated	1.41 x $10^9 m^3$
4	Garbage and other solids	34 x 10^6 tonnes
5	Fertilizer –residue	5 x 10^6 tonnes
6	Synthetic detergents –residue	1,30,000 tonnes
7	Pesticides –residue	65, 000 tonnes
8	Petroleum hydrocarbons (Tar balls residue)	3,500 tonnes
9	Mining rejects, dredged spoils & sand extractions	0.2 x 10^6tonnes

MALDIVES

1. An archipelago comprising of 16 complex atolls, five oceanic faros and four oceanic platform reefs.
2. Marine resources are the main natural endowment with economic activities concentrated on fishing and tourism.
3. No inland fisheries and no organized agriculture.
4. Fishing operations take place in off-shore, coastal and reef waters.
5. Sewage is considered to be the major source of pollution but growing concern about groundwater pollution due to improper use of fertilizers in some islands.

PAKISTAN

1. About 900 km coastline – two distinct units: passive margins of Sindh and the active margin of Balochistan. Sindh coastal belt suffers from serious environmental problems.
2. Metropolitan municipal sewage and industrial effluents are the two major sources of coastal water pollution. >300 Mgd municipal wastewater is discharged in Karachi coastal waters and an estimated BOD load of 1500 tons/d is added into sea by industry.
3. Comparatively older reports indicate that blooms of phytoplankton as well as excessive seaweeds were observed on the tidal flats of Korangi.
4. Overall results indicate a heterotrphic denitrifying system

A summary of various types of pollution at different sites on Karachi coast (+ low, ++ medium, +++ high, ++++ highest)

Area	Levels of Various Types of Pollution						
	Oil on water	Tar on beaches	Tar balls	Industrial	Domestic sewage	Sedimentation	Thermal
Paradise Point	-	-	+	-	-	-	-
Buleji	-	-	+	-	-	-	-
Hawks bay	-	-	+	-	-	-	-
Sandspit	-	-	+	-	-	-	-
Manora Channel	++++	+++	++	++++	++++	++++	+
Clifton	++	-	+	+	+	+	+
Korangi Creek	+	-	++	+	+	+	-

SRI LANKA

1. Five of the nine provinces have a maritime boundary with a 1620 km long coastline.
2. Wide range of geomorphological features including coral reefs, seagrass beds, mangrove forests, salt marshes beaches, coastal wetlands etc.
3. Coastal aquifers, an important source of drinking water in most places appear to be contaminated by nutrient pollutants showing a clear correlation with anthropogenic activities.
4. Coastal waters are polluted due to agricultural activities, release of untreated or partially treated solid wastes and effluents from industries, tourist resorts, aquaculture and sewage.

Agricultural practices leading to nutrient enrichment

South Asia has the largest share (91%) of arable and permanent cropland in total agricultural land. It has 28 per cent of the world's agricultural population, which exists on about 13 per cent of the world's arable land. Except for Maldives, the role of agriculture in South Asian countries is notable playing a very significant role in national economies and rural livelihoods.

While the world demand for total fertilizer nutrients is estimated to grow at 2.0 per cent per annum from 2011 to 2015, Asia is the largest consumer of fertilizer in the world. Total fertilizer nutrient consumption in Asia is 60% of the world total, and South Asia is the second largest fertilizer consuming region in the world (FAO, 2011) with consequent pollution especially related to fertilizer overuse.

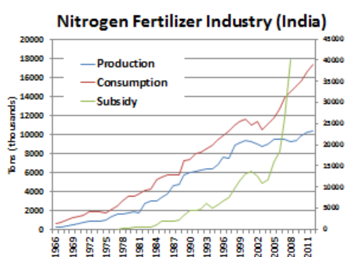
Fertilizer consumption (kg nutrient per hectare of arable land)

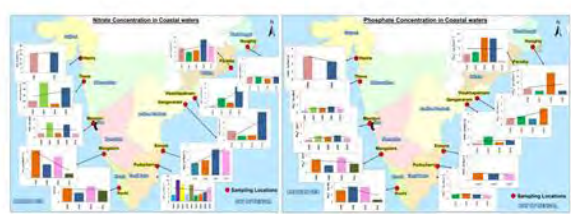
Countries	Year								
	2002	2003	2004	2005	2006	2007	2008	2009	2011
Bangladesh	188.64	160.27	170.67	197.75	193.19	184.41	200.06	160.96	184.36
India	100.64	105.13	115.44	127.80	136.35	142.76	153.42	167.56	178.53
Maldives	6.00	8.00	10.37	29.67	117.67	87.33	22.33	7.33	3.66
Pakistan	140.84	145.95	157.67	175.19	177.51	169.81	171.93	242.16	217.14
Sri Lanka	304.56	259.18	287.01	255.29	291.31	288.52	311.71	281.37	280.75
South Asia	-	-	115.04	129.90	136.40	142.80	153.40	167.40	174.30

Source: http://data.worldbank.org/indicator/AG.CON.FERT.ZS/countries

Seasonal variation of Total Phosphorus (TP) and Total Nitrogen (TN) in three river systems of Bangladesh river systems between September 2010 and February 2011 (Bir and Siraj, 2013)

River	Season	TP mg/l	TN mg/l
Rupsha-Passur River	post monsoon	0.326~0.409	2.52~3.50
	winter	0.091~0.371	3.43~5.25
	pre monsoon	0.475~0.144	2.31~3.61
Arpangashia-Malancha River	Winter	0.060~0.113	3.22~5.95
Baleswar-Bhola River	Rainy	0.106~0.364	2.59~3.57
	Dry	0.053~0.075	2.87~5.60





Nitrate (A) and phosphate (B) concentrations in coastal waters of India (Based on COMAPS data)

Range of nitrate and phosphate contents of different wells in Jaffna and Kilinochchi districts, Sri Lanka

Types of wells	Range of NO_3-N (mg/l)	Range of phosphate (mg/l P)
Jaffna Peninsula		
Farm wells	1.0 – 55.7	0.001- 0.20
Domestic well	0.2 – 30.8	0.002-0.010
In Island		
Farm wells	0.1-95.0	-
Domestic wells	0.1-10.0	-
Kilinochchi		
Shallow well	0.9-2.6	Nd
Tube well	0-1-5.1	Nd

Source: Nagarajah et al., 1988

Aquaculture practices leading to coastal pollution

1. BANGLADESH
   Shrimp represents Bangladesh's second largest export. Mean levels of nutrients are found to be higher in sediments of cultured ponds.
2. INDIA
   In 2012, shrimp accounted for around 50% of the value of seafood export. There are reports of pollution loads due to shrimp aquaculture and algal overgrowth is indicative of nutrients sourced from aquaculture.
3. MALDIVES
   Since mari-culture industry relies on wild stock, no report on pollution from aquaculture.
4. PAKISTAN
   Shrimp culture not a significant activity
5. SRI LANKA
   BOBLME report (2013) suggest that much of coastal pollution inNorthwestern province due to ad hoc development of aquaculture.

NATIONAL, LEGAL AND POLICY FRAMEWORKS

All the countries in the region have well-defined legislation and policy frameworks in place including:

1. National Environmental Policy
2. National Agriculture Policy
3. National Fertilizer and agrochemical Poliy
4. National Aquaculture Policy
5. ICZM etc.

However, lapses in their implementation and monitoring are visible.

Gaps in knowledge

Although there could be location-specific issues, most of the important information gaps for prudent management of the coastal/marine environment in the south Asian Seas region include:

- Seasonal and annual variation in pollution loads from land-based activities,
- Extent of contamination of coastal sediments,
- Coverage, treatment types, and discharge data for urban sewerage systems.
- Knowledge about the chemical, physical, hydrological and biological processes taking place in estuaries, marine habitats, coastal waters and the inter-dependency among various marine resources.

Gaps in knowledge…….

- Impact of coastal aquaculture on mangroves and other coastal habitats,
- Coastal erosion due to human activities
- Ballast water disposal into coastal waters and its impact on Invasive Alien Species, marine litter data
- Oil pollution from ports, oil rigs as well as spills during transportation
- Information on bioaccumulation, bioconcentration, biomagnification and trophic transfer of critical pollutants

Policy actions to address gaps

1. Effective ecosystem-based actions need to integrate social, economic and environmental concerns, the cornerstones of sustainable development. The following are some of the issues crying for attention for defined policy actions:

   - *Ecology*: Strict enforcement of laws and policies.
   - *River management*: River conservation program having direct linkage with coastal habitat conservation.
   - *Develop quality standards for coastal waters*: A uniform standard on primary water quality criteria for the coastal waters and designated best use.

Policy actions to address gaps…..

2. Nutrient use efficiency and site-specific nutrient management should be emphasized in the existing policies and programs in all aspects agriculture, aquaculture, poultry, livestock farming to minimize nutrient leakages throughout the food chain. They should be enforced and monitored periodically through a joint task force comprising relevant scientific, administrative and civil society stakeholders.
3. Sustainable nutrient management should be emphasized, enforced and monitored as above in the existing policies and regulations on municipal wastes, industrial effluents etc., specifying nutrient contamination limits and mandating their recovery and recycling.

Policy actions to address gaps…..

4. Effective policies are needed for land zoning of industries, strengthening sanitation and water quality monitoring with enforcement of the environmental conservation policies on waste treatment and nutrient recycling at all point sources.
5. Policies for phasing out of phosphate containing detergents and other products that tend to cause nutrient loading of the environment in general and water bodies in particular.
6. National Sewage treatment missions should be initiated with specific annual targets and provisions for public reporting of progress and civil society oversight, to protect water bodies from nutrient, organic and other pollution

Policy actions to address gaps…..

7. Innovative new policies to combine the social benefits of eradicating open defecation with technologies (such as composting toilets or treatment plants) for recycling human wastes as fertilizers, along with awareness programs to highlight the health hazards of untreated use of human excreta (or sewage contaminated with them) for crop production.
8. Marine Protected Areas should be identified in the coastal areas and conserved, involving governmental, non-governmental and community participation.
9. National marine environment research institutions should be established/ strengthened with specific mandate for coastal zone pollution studies and nutrient pollution abatement in each of the south Asian countries, with mechanisms for collaboration and data sharing.

Policy actions to address gaps…..

10. Each South Asian country should have a national level inter-ministry and inter-agency multi-stakeholder coordinating body for effective policy formulation and implementation of sustainable nutrient management involving relevant national and local governmental bodies and non-governmental organizations, scientists, engineers, industry and civil society to combat coastal pollution.
11. There is a strong need for a South Asian level Intergovernmental working group/task force for coordinated sustainable nutrient management and protection of the region's coastal and marine environment, with governmental and civil society representatives from the above national bodies. This may work within, or coordinate with the existing intergovernmental processes including the UNEP-GPA, SAARC, the BOBLME project etc. and build on them for stronger regional cooperation on nutrient management.

Recommendations

1. Nutrients like N and P that are necessary for food production should be captured and recycled for food production. Appropriate R&D efforts to increase the nutrient-use efficiency to maintain agricultural productivity and low nutrient use.
2. Treatment of sewage before it is let into receiving waters is limited and hence sewage treatment, preferably upto tertiary level should be implemented.
3. Survey and research work to critically understand the interaction of numerous natural and man-made factors to water bodies, economic valuation of important features such as wetlands, studies on pollution loads of rivers and major water bodies in the region.

Recommendations…….

4. Ecosystem health report cards for reporting the health of a waterway at both local and regional scales.
5. Greater stakeholder involvement to create and support the existing program for spreading awareness and educating stakeholders about the basis of sustainable development.
6. Adequate national and local legislations to implement international commitments have to be put into place in a time-bound manner. A close-coordination including exchange of data and scientific information through use of ICT is essential to move forward in this direction. Regional multi-lateral bodies like SACEP can play an active role in introducing collaborative research efforts.

CONCLUSION

The TDA of the BOBLME identifies three main transboundary issues: (a) Overexploitation of marine living resources, (b) Degradation of mangroves, coral reefs and seagrasses and (c) Pollution and water quality.

South Asian estuaries appear to be largely heterotrophic and denitrifying systems and hence may be influenced by N pollution. Inorganic fertilizer usage has been steadily increasing in India and Pakistan and is likely to contribute to an increased leakage of fertilizer residues to the coastal waters.

An integrated approach towards studying and implementing proper management of South Asian Seas and long-term sustainability of its natural resources are essential.

Thank you

Annex 4.6: Presentation by Resource Persons

- *New direction in Implementing the GPA*

GPA GLOBAL PROGRAMME OF ACTION FOR THE PROTECTION OF THE MARINE ENVIRONMENT FROM LAND-BASED ACTIVITIES

New direction in Implementing the GPA

Prepared by:

Vincent Sweeney

Coordinator, GPA

UNEP

GPA GLOBAL PROGRAMME OF ACTION FOR THE PROTECTION OF THE MARINE ENVIRONMENT FROM LAND-BASED ACTIVITIES

What is the GPA?

The **GPA**, adopted in 1995, is a voluntary, action-oriented, intergovernmental programme led by UNEP, to prevent the degradation of the marine environment from land-based activities.

- Intergovernmental Review (IGR) Meetings are held every 5 years to chart the future direction for the GPA
- Held previously in Montreal and Beijing
- The Third IGR was held in January 2012, in Manila. It recognized the limitations of the GPA Secretariat and led to the Manila Declaration and approval of a new focus for the GPA.

GPA GLOBAL PROGRAMME OF ACTION FOR THE PROTECTION OF THE MARINE ENVIRONMENT FROM LAND-BASED ACTIVITIES

What does GPA prioritize?

The Manila Declaration in 2012, gave GPA the mandate to establish three global multi-stakeholder partnerships for the priority areas nutrients, marine litter and wastewater

- **Global Partnerships:**
  - The **GPNM,** launched at the UN CSD in New York, May 2009
  - The **GPML,** launched at Rio+20, June 2012 and had its first Partnership Forum in Montego Bay, Oct 2013
  - The **GWI,** announced by Achim Steiner in May, 2013; officially met for the first time in Montego Bay on Oct 4, 2013

GPA GLOBAL PROGRAMME OF ACTION FOR THE PROTECTION OF THE MARINE ENVIRONMENT FROM LAND-BASED ACTIVITIES

Global Partnership on Nutrient Management (2009)

→ to promote the effective nutrient management to achieve the twin goals of food security through increased productivity and conservation of natural resources and the environment

Multi-Stakeholder Partnership:

- **IGOs:** e.g. FAO; EC; SACEP; IOC/UNESCO, UNDP, IAEA, PEMSEA, BOBLME
- **Governments**: e.g. USA, India, China, Italy, Indonesia, Thailand, the Netherlands
- **NGOs**: e.g. IPNI; IFDC; TNC
- **Academia**: e.g. Universities in China, Thailand, India, Cyprus, UK, Netherlands, USA
- **Private sector**: e.g. IFA; GETF

UNEP's Role:

- Facilitate and use its convening power to bring together the various stakeholders
- Coordinate with relevant initiatives, e.g. International Nitrogen Initiative

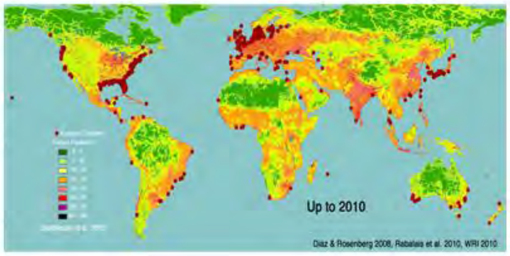
GPNM Global Partnership on Nutrient Management

DEAD ZONES!!

>500 eutrophic/ hypoxic coastal systems

>245,000 km2 of water area worldwide

Global loss of ecosystem services =USD 200 billions/year



DEAD ZONES!!

The GPNM recognises the need for strategic advocacy and co-operation at the global and regional levels

Foresee its role:

- **to provide information and enhance capacities to design and implement effective management policies to address the growing problem of nutrient over-enrichment**
- **to support science policy interaction and translate science for policy makers**
- **to position nutrient issues as part of the international sustainable development agenda**

The GPNM held a Partnership Forum during the 2nd Global Land-Oceans Connections Conference, Oct 2013:

Recommended solutions to nutrient loading included:

- **Promoting Fertilizer Best Management Practices (such as soil fertility and soil conservation); and**
- **Improving nutrient use efficiency in agriculture.**

A number of research topics and economic assessments were proposed, as well as indicator development, awareness-raising and education. Details available from www.gpa.unep.org

Global Partnership on Marine Litter (2012)

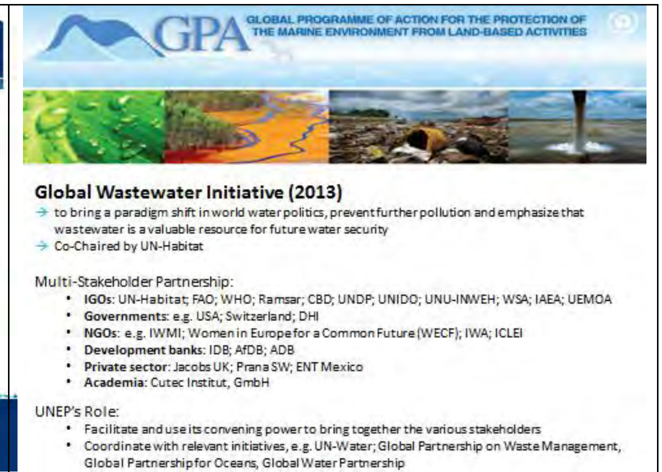
- → Seeks to protect human health and the environment by the reduction and management of marine litter
- → Facilitates the implementation of the Honolulu Strategy – A global framework for the prevention and management of marine debris
- → Supports the implementation of the Global Partnership on Waste Management

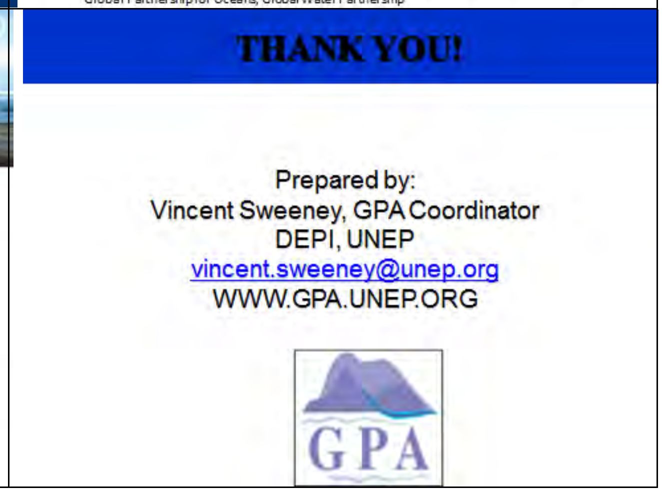
Multi-Stakeholder Partnership:

- **IGOs:** UNEP (land-based sources); FAO and IMO (sea-based sources)
- **Governments:** e.g. USA, Norway & the Netherlands
- **NGOs:** e.g. NRDC, Plastics Disclosure Project, Plastics Pollution Coalition, 5 Gyres
- **Private sector:** e.g. Plastics Europe

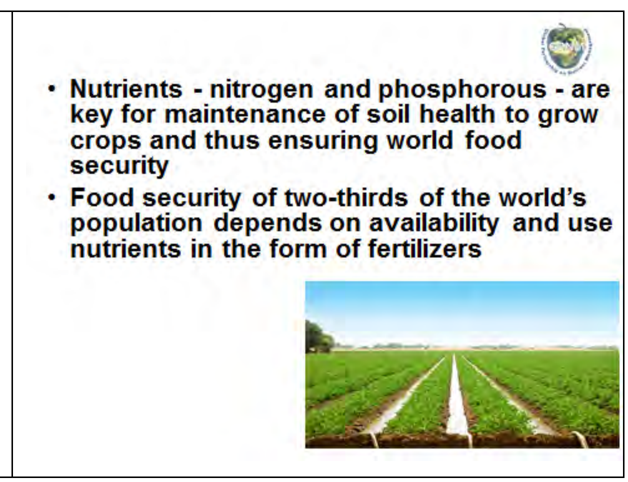
UNEP's Role:

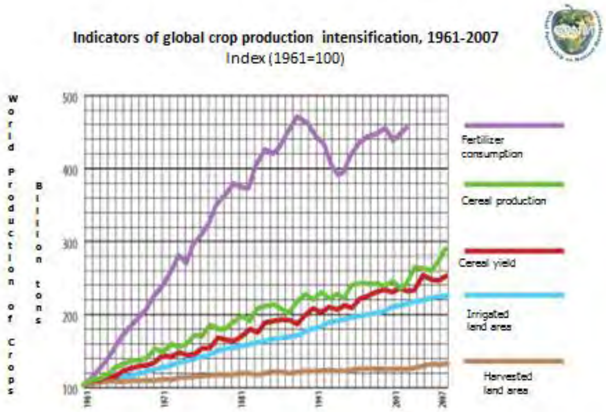
- Facilitate and use its convening power to bring together the various stakeholders
- Coordinate with relevant initiatives, e.g. Global Partnership on Waste Management, Global Partnership for Oceans, CMS and CBD



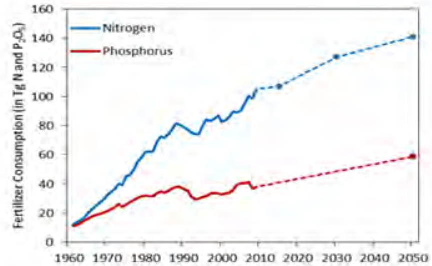


- ***Global Partnership on Nutrient Management (GPNM)to promote sustainable nutrient management for food security and ecosystems' health***

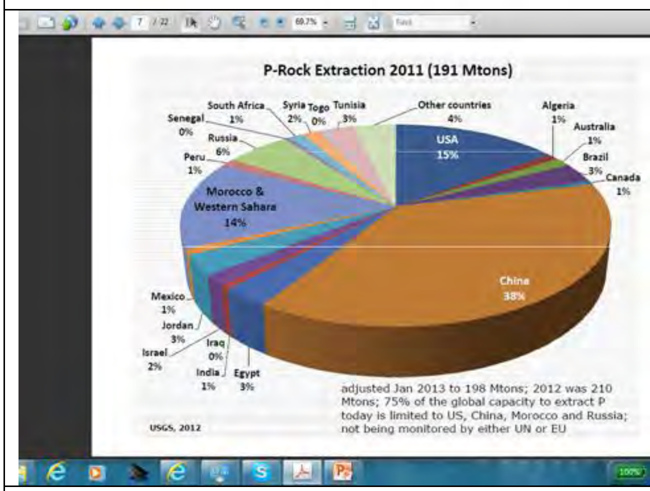


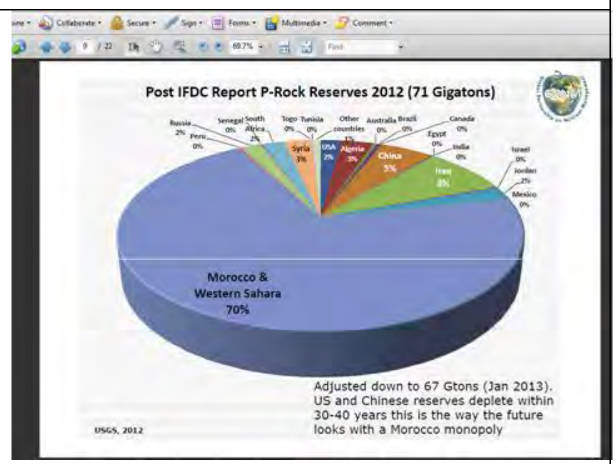


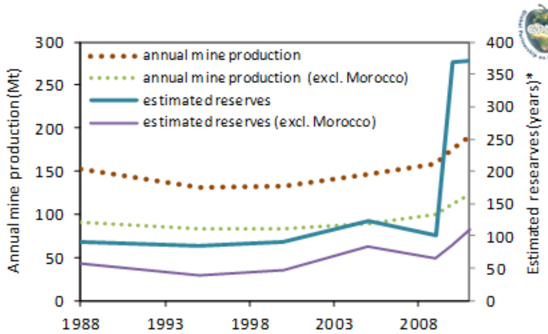
Source: Save and Grow, FAO 2011



Trends in global consumption of mineral fertilizer (nitrogen and phosphorus) and projected possible futures







The estimated reserves without Morocco are shown based on current total global production, assuming that this is market driven.

"I cannot overemphasize the importance of phosphorus not only to agriculture and soil conservation but also to the physical health and economic security of the people of the Nation. Many of our soil types are deficient in phosphorus, thus causing low yields and poor quality of crops and pastures..."

Franklin D. Roosevelt
XXXII US President
1933-1945
President's message to Congress on Phosphorus for Soil Fertility
May 20, 1938

Unintended impacts of Nutrients

- Evidence suggests that chemical fertilizers are often over-applied, or applied at a time when they cannot be effectively utilized by crops
- Nearly 75% of added nutrients is lost to the environment, wasting the energy used to produce them and causing pollution through emissions of the greenhouse gas nitrous oxide (N_2O) and ammonia (NH_3) to the atmosphere, plus losses of nitrates (NO_3), phosphate and organic N and P compounds to water.

•FAO predicts that by 2030 global nitrous oxide (N_2O) emission from fertilizer and manure application will increase by 35% to 60%

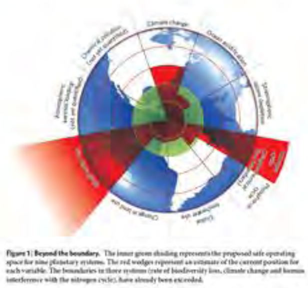
•Global Warming Potential of N_2O is 296 times greater than a unit of CO2

•The **State of the World's Land and Water Resources for Food and Agriculture** (2011) notes that while the last 50 years witnessed a notable increase in food production, "in too many places, achievements have been associated with management practices that have degraded the land and water systems upon which food production depends."

•During 1981 – 2003 nearly 25% of the global land area got degraded i.e., reduction in the capacity of the land to provide ecosystem goods and services over a period of time

Planetary Boundaries

due to human interference the nitrogen cycle has gone beyond appropriate global limits



Source: Johan Rockström et al, in The Nature 24 September 2009

The five key threats of excess nutrients

The WAGES of too much or too little of nutrients

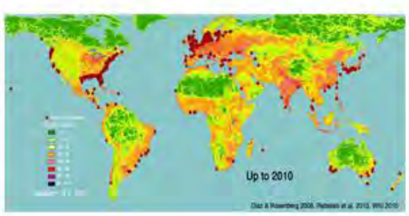
Water quality
Air quality
Greenhouse balance
Ecosystems
Soil quality

Modified from the European Nitrogen Assessment (2011)

Nutrients cause eutrophication (leading to adverse impacts including mortality of benthic organism, collapse of fisheries and shellfish poisoning)

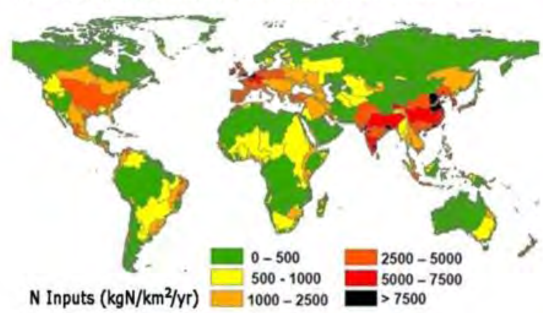
>500 eutrophic/ hypoxic coastal systems

>245,000 km2 of water area worldwide

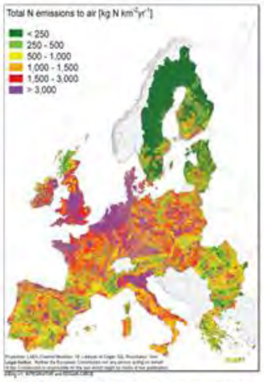


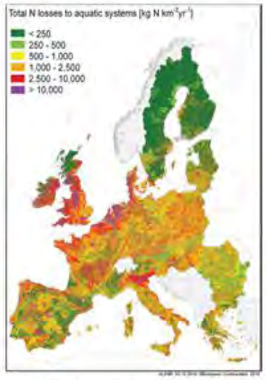
Global loss of ecosystem services =USD 200 billions/year

Too Much and Too Little of Nutrients: regional variations



Estimated net anthropogenic nitrogen inputs according to the world's main river catchments (Source: Our Nutrient World 2013).





Estimated distribution of reactive nitrogen emissions across Europe (expressed as kg N per km² for 2000) including (**left**) emissions to air as the sum of NO_x, NH_3 and N_2O, and (**right**) total losses tc aquatic systems, including nitrate and other N_r leaching and wastewaters. These high spatial resolution of the maps illustrates the challenge of managing nitrogen flows given the wide spatial variation experienced (based on Leip et al., 2011).

The Nutrient Challenge

A **seeming divide** between societal needs for food and energy and a complex web of adverse environmental impacts..............

*This divide – '**the nutrient challenge**'- **is set to intensify**, to the cost of countries, as population, urbanisation and food and energy demands increase.*

Greatest Challenge: How to realize the dream of 4 WINs at the same time?

- **High crop yield**
- **High efficiency of resource use (NUE)**
- **Improved soil fertility and**
- **Better environment quality**

The Global Partnership on Nutrient Management (GPNM) has been launched to answering this challenge

- a multi stakeholders global partnership of governments, science community, industry, NGOs and international organisations

- an One UN initiative

- guided by a Steering Committee; UNEP is the Secretariat

GPNM Members are:

Government
Intergovernmental Bodies
Industry
Scientific and Research Institutions
UN Agencies
NGOs/CSOs
Regional projects

Role of the GPNM

- strategic advocacy and co-operation at the global and regional levels to build consensus in promoting nutrient use efficiency and work with stakeholders to develop guidance, strategies or policies on sustainable use of nutrients
- enhancing the capacities of various stakeholders to design and implement effective management policies
- a knowledge platform to support science policy interaction and translating science for policy makers
- positioning of nutrient issues as part of international sustainable development agenda

Role of the GPNM

- innovation and knowledge regeneration to reduce nutrient losses and improve overall nutrient use efficiency
- 20% relative improvement in NUE by 2020 would lead to an annual saving of around 20 m tonnes of nitrogen = to an initial estimate of improvement in human health, climate and biodiversity worth around $100 billion per year.

Our Nutrient World
The challenge to produce more food and energy with less pollution

Global Overview on Nutrient Management

UNEP GPA GPNM INI GLOBAL IGBP CHANGE SCOPE

20% improvement in NUE by 2020 would lead to an annual saving of around 20m tonnes of nitrogen = to an initial estimate of improvement in human health, climate and biodiversity worth around $100 billion per year.

Nutrients – in the Global Agenda

CBD Aichi Target 8: calls for action to reduce pollution, including from ***excess nutrients***, to levels that are not detrimental to ecosystem function and biodiversity, and the sustainable development goals.

GPA IGR-3 Manila Declaration: adopted by 64 governments and the EU in January 2012 called for further development of the GPNM and associated regional and national stakeholder partnerships, as well as their activities ....(and) "to step up efforts to develop guidance, strategies or policies ..... so as to improve nutrient use efficiency..., and to mitigate negative environmental impacts through the development and implementation of national goals and plans...".

The Rio+20 Outcome document notes "with concern that the health of oceans and marine biodiversity are negatively affected by marine pollution, including marine debris ...... and ***nitrogen-based compounds***...." (para 163)

UN SG's Oceans Compact calls for "reducing pollutants from sea and land-based activities, including .... litter, harmful substances and ***nutrients from wastewater, industrial and agricultural runoff entering the world's oceans***"

All positive signals of governments commitment and good starting points

Summing Up

Managing nutrients efficiently is relevant to food and energy security, water quality and availability, biodiversity and fisheries, and climate change

To meet the nutrient challenge we need to improve NUE

Responsibility for action to promote sustainable production and use of nutrients lies with countries

The *GPNM - provides the space* where countries and other stakeholders can forge more co-operative work across the variety of international & regional fora and agencies dealing with nutrients

Effective nutrient reduction strategies would call for new approaches and outreach to society. GPNM is addressing this through its network of members

It is important that we acknowledge the role of governments, industry, science community, international agencies, CSOs, regional bodies to address the Nutrient Challenge and to accelerate our efforts to understand how the Earth's ecosystems are impacted by unsustainable use of Nutrients

SCAEP/SAS in the light of the 2013 IGM decision is well positioned to work with governments and other stakeholders in creating enabling conditions for development of appropriate public policies and ensuring their implementation and monitoring

Let us acknowledges the value of partnering to secure the Harvest

Green Fields and Blue Oceans

THANK YOU

- ***Wastewater and septage: turning an environmental hazard into a safe asset***

Wastewater and septage:

turning an environmental hazard into a safe asset

Javier Mateo-Sagasta
22/05/2014
Workshop on nutrient pollution in South Asia
Colombo, Sri Lanka

IWMI

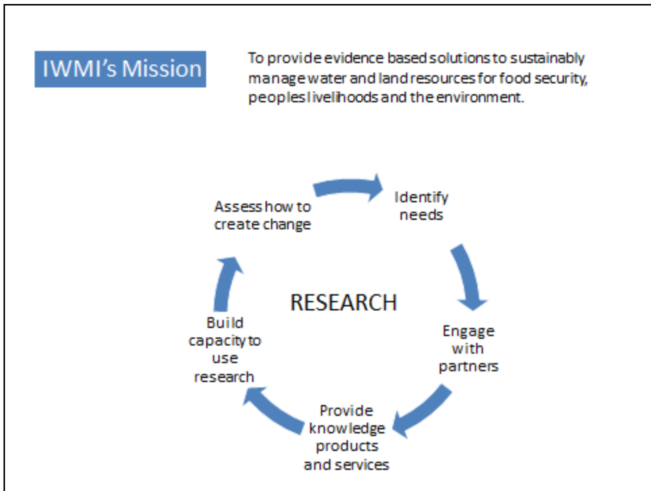
A water-secure world
www.iwmi.org

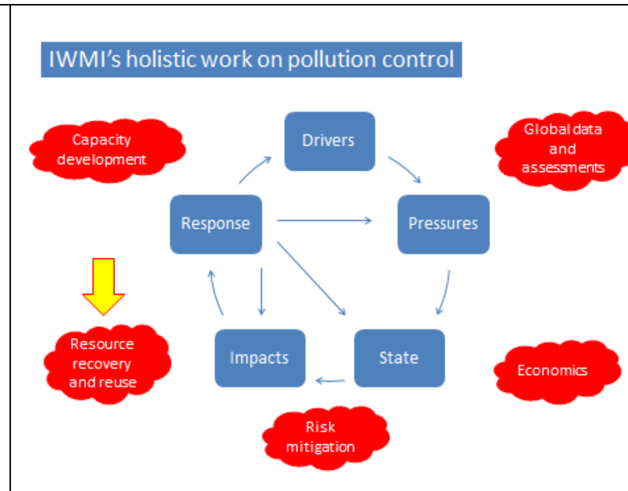
Content

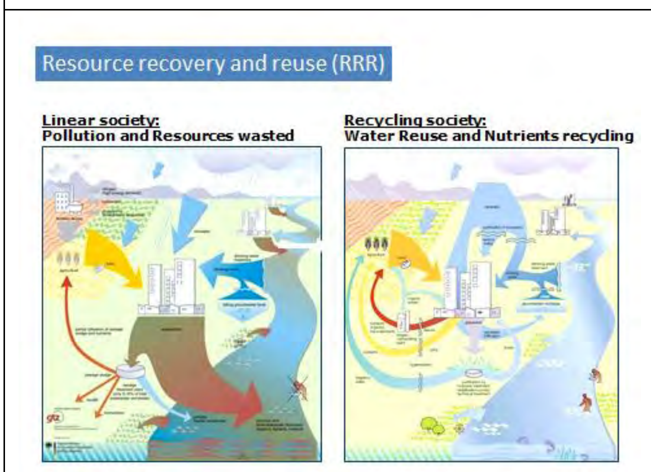
- IWMI holistic work on pollution control
- Resource Recovery and Reuse
  - Bangladesh
  - Sri Lanka

IWMI

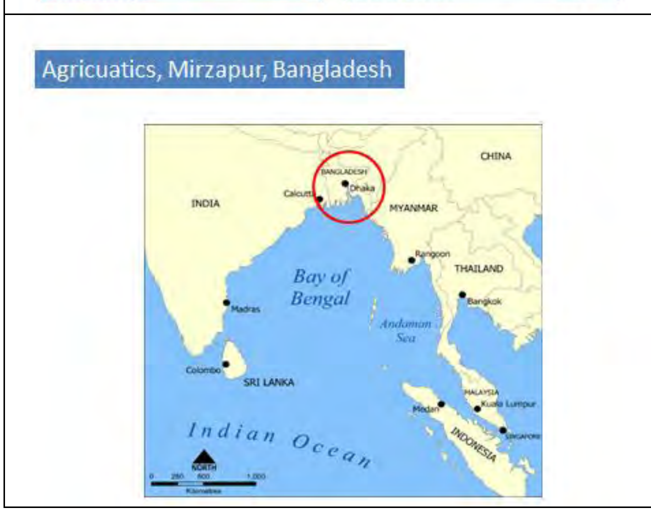
A water-secure world
www.iwmi.org


IWMI's Mission
To provide evidence based solutions to sustainably manage water and land resources for food security, peoples livelihoods and the environment.
RESEARCH
Identify needs
Engage with partners
Provide knowledge products and services
Build capacity to use research
Assess how to create change


IWMI's holistic work on pollution control
Capacity development
Drivers
Global data and assessments
Response
Pressures
Resource recovery and reuse
Impacts
State
Economics
Risk mitigation


Resource recovery and reuse (RRR)
Linear society:
Pollution and Resources wasted
Recycling society:
Water Reuse and Nutrients recycling


Business models for RRR
Case analysis, business models catalogue, feasibility studies, piloting, up-sacaling and replications plans


Agricuatics, Mirzapur, Bangladesh
CHINA
INDIA
BANGLADESH
Dhaka
MYANMAR
Rangoon
THAILAND
Bay of Bengal
Bangkok
Madras
Andaman Sea
Colombo
SRI LANKA
Indian Ocean
INDONESIA


Business case
0.6 ha plug flow duckweed pond
Farmed duckweed
Duckweed fertilized fish ponds
Harvested fish

Business case

Wastewater Input: Wastewater from a complex of 3 000 p.e.

Value-added products: Carp Species, co-crops

Public acceptability: High. Constant demand for fish

Capital requirements: USD 100 000 plus existing 4 lagoons

Labour requirements: 4 persons for 1 hour/day -7 days/week

Output: 7.5 tonnes of carps at an average price of USD 3/kg

Gain: 4 part time jobs, inexpensive source of fish and cleaner environment

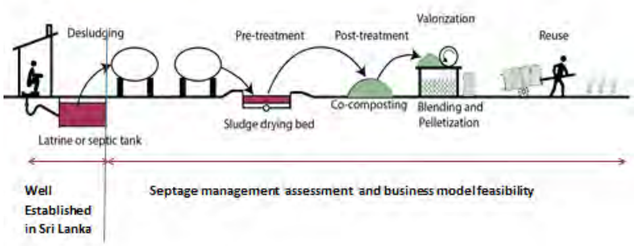
Viability indicators: payback period 6 years, gross margin 20%

Status of firm: Operational (1989)

Major partners: Prism Bangladesh (NGO) / Kumudini Welfare Trust

Septage Management in Sri Lanka

Septage Management in Sri Lanka



Septage Management Assessment

335 LAs in Sri Lanka

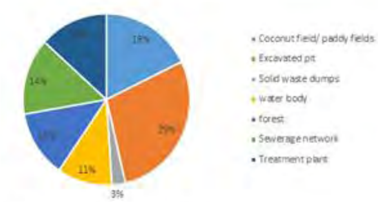
About 1650 m3 of FS are produced per day (i.e. 600,000 m3 per year)

59% of all LAs have access to septage collection services, public or private (NSWMSC, 2012)

Together, all service providers collect only 10% of the septage produced (IWMI field survey 2013)

Septage Management Assessment

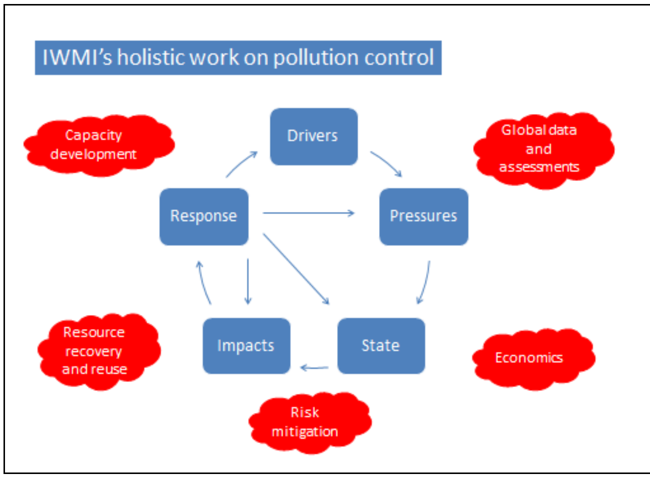
From the 10% septage that is actually collected:



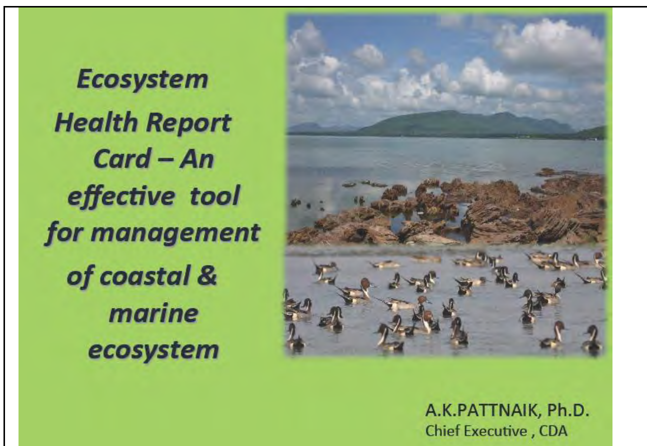
Source: Fecal Sludge Management Policy symposium (2008)

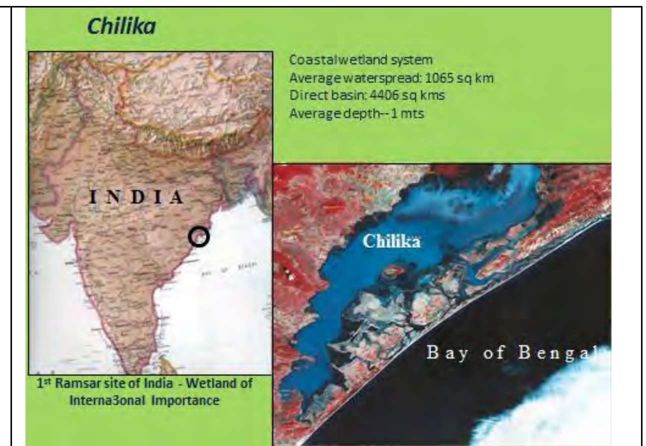
One septic truck dumped into nature = open defecation of 5000 people!!

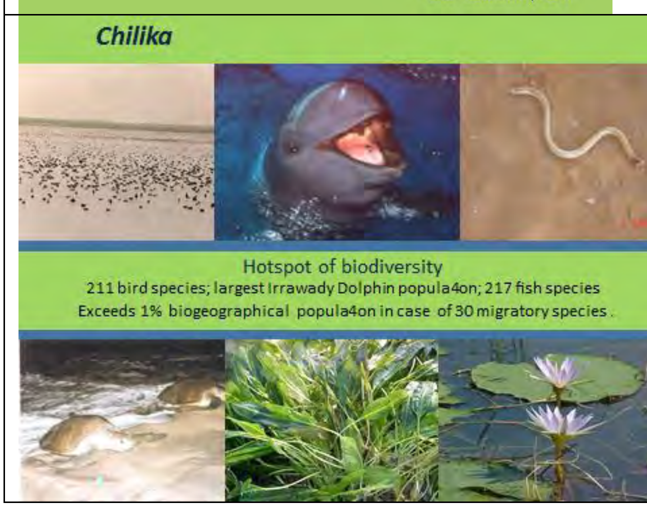
Business model feasibility



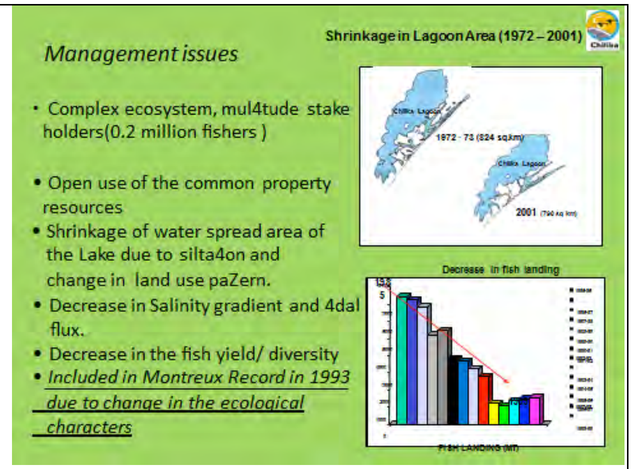
- ***Ecosystem Health Report Card An effective tool for management of coastal & marine ecosystem***



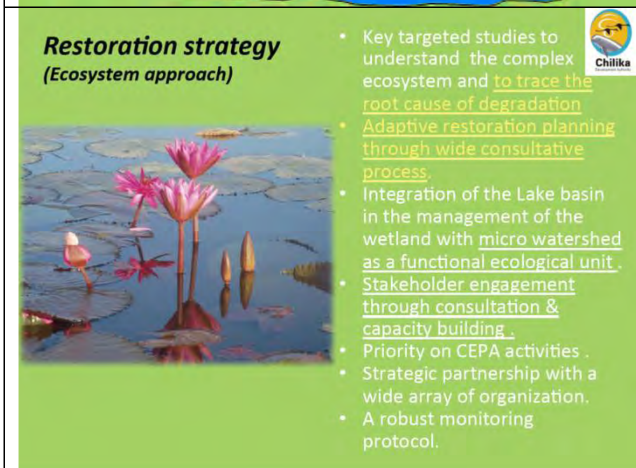




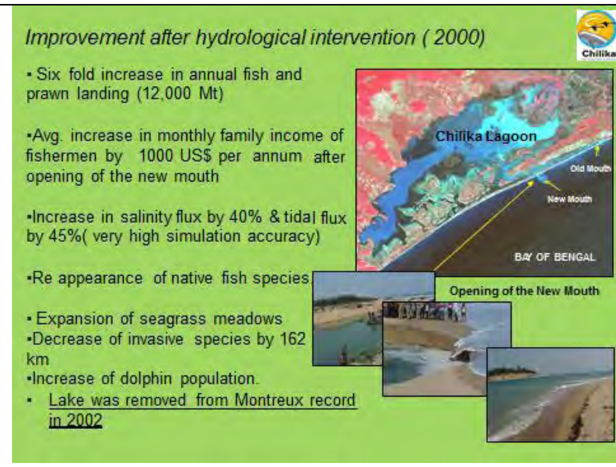
Hydrological set-up of Chilika Lagoon
Chilika
Alteration of Flow
Western Catchment
CHILIKA LAGOON
Mahanadi Delta
B A Y O F B E N G A L



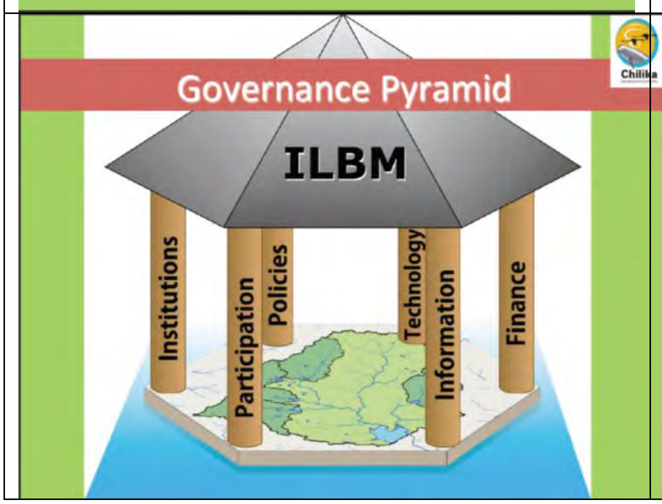
Management issues
Shrinkage in Lagoon Area (1972 – 2001)
• Complex ecosystem, mul4tude stake holders(0.2 million fishers)
• Open use of the common property resources
• Shrinkage of water spread area of the Lake due to silta4on and change in land use paZern.
• Decrease in Salinity gradient and 4dal flux.
• Decrease in the fish yield/ diversity
• Included in Montreux Record in 1993 due to change in the ecological characters
1972 - 73 (824 sq.km)
2001
Decrease in fish landing
FISH LANDING (MT)



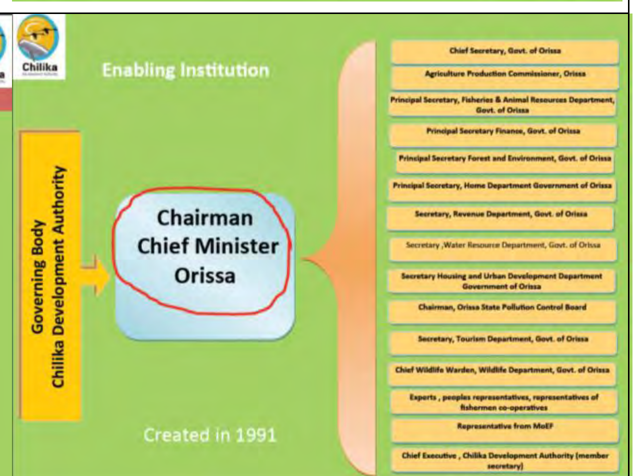
Restoration strategy
(Ecosystem approach)
Chilika
• Key targeted studies to understand the complex ecosystem and to trace the root cause of degradation
• Adaptive restoration planning through wide consultative process.
• Integration of the Lake basin in the management of the wetland with micro watershed as a functional ecological unit .
• Stakeholder engagement through consultation & capacity building .
• Priority on CEPA activities .
• Strategic partnership with a wide array of organization.
• A robust monitoring protocol.



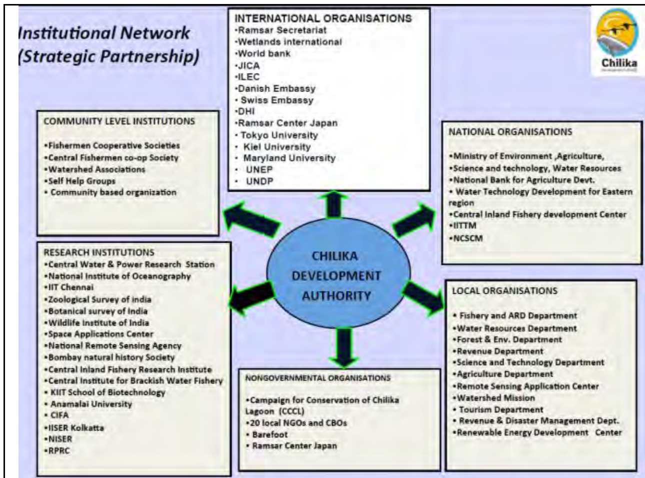
Improvement after hydrological intervention (2000)
Chilika
• Six fold increase in annual fish and prawn landing (12,000 Mt)
•Avg. increase in monthly family income of fishermen by 1000 US$ per annum after opening of the new mouth
•Increase in salinity flux by 40% & tidal flux by 45%(very high simulation accuracy)
•Re appearance of native fish species
• Expansion of seagrass meadows
•Decrease of invasive species by 162 km
•Increase of dolphin population.
• Lake was removed from Montreux record in 2002
Chilika Lagoon
Old Mouth
New Mouth
BAY OF BENGAL
Opening of the New Mouth



Governance Pyramid
Chilika
ILBM
Institutions
Participation
Policies
Technology
Information
Finance



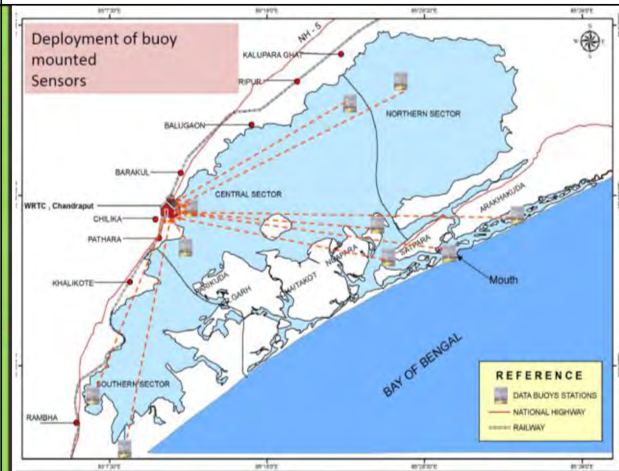
Chilika
Enabling Institution
Governing Body
Chilika Development Authority
Chairman
Chief Minister
Orissa
Created in 1991
Chief Secretary, Govt. of Orissa
Agriculture Production Commissioner, Orissa
Principal Secretary, Fisheries & Animal Resources Department, Govt. of Orissa
Principal Secretary Finance, Govt. of Orissa
Principal Secretary Forest and Environment, Govt. of Orissa
Principal Secretary, Home Department Government of Orissa
Secretary, Revenue Department, Govt. of Orissa
Secretary ,Water Resource Department, Govt. of Orissa
Secretary Housing and Urban Development Department Government of Orissa
Chairman, Orissa State Pollution Control Board
Secretary, Tourism Department, Govt. of Orissa
Chief Wildlife Warden, Wildlife Department, Govt. of Orissa
Experts , peoples representatives, representatives of fishermen co-operatives
Representative from MoEF
Chief Executive , Chilika Development Authority (member secretary)



Available

Monthly data	Duration	No. of stations
Water Quality	1998- till date	30
Nutrients	1999-2012	30
Chlorophyll	2006-2008 2011-2012	8 13
Phytoplankton	2011-2012	13
Zooplankton	2011-2012	13
Benthos	2011-2012	30
Fish landing	2000-2012	28 landing stations

Deployment of buoy mounted sensors at 10 strategic locations
Parameters : Salinity, DO, pH, Chlorophyll, Blue green algae
Water temp., Turbidity
Real time -15 minute interval.



Ecosystem Health Report Card

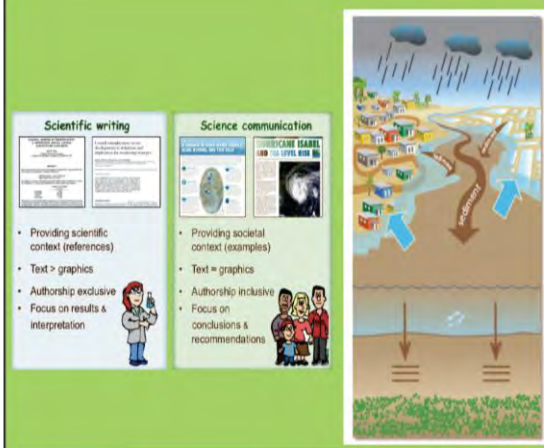
- Environmental report cards are transforma4ve assessment and communica4on products that compare environmental data to scien4fic or management thresholds and are delivered to a wide audience on a regular basis.
- To fascilitate science to become policy relevant .

Core Objectives

- Define the basic indicators and their values to ascertain the health of the lake for the report card .
- Understand the role of river-catchment and freshwater nutrient input and associated nutrient fluxes to Chilika Lake
- Determine the transport of nutrient from the major/ minor rivers into the lake
- Assess the biogeochemical coupling of nutrient inputs with other physical components of the Chilika Lake system
- Analyse and carry out modelling of existing data in support of bridging data gaps in the report card.

Easy accessibility, wider audience

- <u>The report card provides a transparent, timely, and geographically detailed annual assessment of the health of the ecosystem using key indicators that are combined into a single overarching index of health.</u>
- It could stimulate the local community to protect their Lake and inspire politicians to provide policy support and fund for restoration activities.
- <u>Civic leaders and community members can compare their grades with their neighbours, and these comparisons lead to a desire for better environmental outcomes in their own neighbourhood.</u>



Goals

- Develop an **<u>integrated ecosystem health assessment</u>** for the Chilika Lake using the identified reporting indicators and top-level indices.
- Create a **<u>ranking valuation scheme</u>** to compare ecosystem health assessments both geographically and over time (annual assessments).
- Effectively **<u>communicate the integrated ecosystem health assessments</u>** with spatially explicit maps and rigorous scientific analyses to all stakeholders (i.e., the policy makers, managers, resource users and the larger community members whose actions impact the health of the Chilika Lake.

Methodology

- Understanding the environmental characteristics
- Identify key parameters, pressure & values .
- Making of graphic presentation with the knowledge of Ecosystem environment and activities in and around the Lake.
- Deciding indicators based on Values and Pressures
- Fixing of thresholds based on professional judgment form long term data set
- GRADINGS: By comparison of the observed present data with threshold values
- Presentation can be seasonal, Annual, sectoral depending on the spatio-temporal variability of environmental parameters.

Methodology: Thresholds

Category	Indicator	Desired condition
Water Quality	Water clarity	≤ 30 NTU
	Dissolved oxygen	≥ 5 mg/L or 60% sat.
	Total chlorophyll	≤ 5 µg/L
Fisheries	Total catch	% deviation above or below maximum sustainable yield (11,500 t/yr)
	Commercial species diversity	Ratio of species landed:desired (45 sp. desired)
	Size	Proportion of species landed above a sustainable size limit. *M. cephalus*: 219 - 461 mm; *P. monodon*: 116 - 197 mm; *S. serrata*: 87 mm
Biodiversity	Bird count and richness	Ratio to maximum bird count and diversity recorded since 2003
	Dolphin abundance	Ratio to maximum dolphin count recorded since 2001
	Benthic infauna diversity	Simpson's Index of Diversity (1-D)
	Phytoplankton diversity	Simpson's Index of Diversity (1-D)

A: 80-100%
All water quality and biological health indicators meet desired levels
quality of water in these locations tends to be excellent,
very good for fish and shellfish habitats

B: 60-80%
Most water quality and biological health indicators meet desired levels
quality of water in these locations tends to be very good
very good for fish and shellfish habitats

C: 40-60%
Mix of good and poor level of water quality and biological health indicators
quality of water in these locations tends to be fair
habitat for fish and shellfish habitats

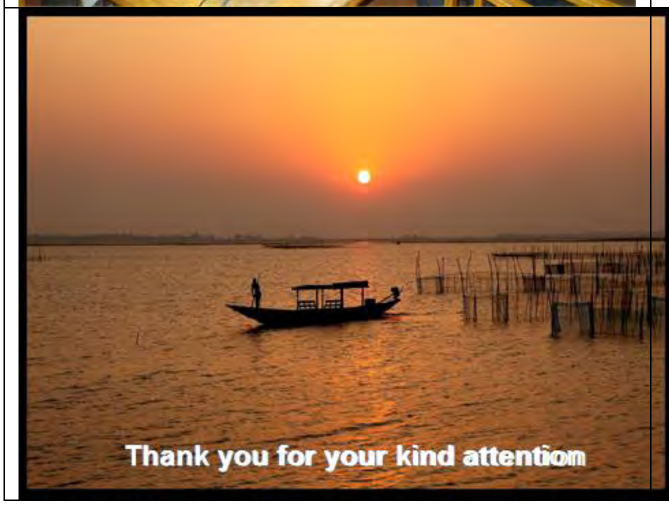
D: 20-40%
Some or few water quality and biological health tends to be poor
often leading to poor habitat conditions for fish and shellfish
F: 0-20%
Very few or no water quality and biological health indicators meet desired levels
quality of water tends to be very poor.

Outcome

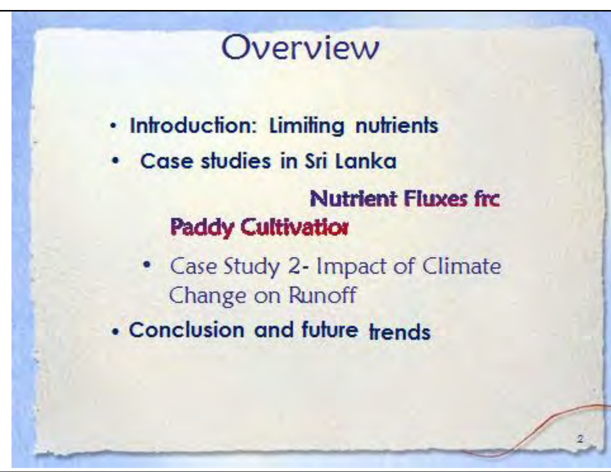
- Overall, Chilika Lake scored "B" for ecosystem health based on performance of fisheries, and biodiversity indices.
- The Lake as a whole displayed excellent (**A**) dissolved oxygen concentrations, water clarity, total fishery catch and size, and benthic infauna diversity.
- The Lake failed, however, for total chlorophyll concentrations (**F**), based on desired conditions.
- Chl-a would be the better indicator than Total Chl. And will be used after collection of enough data to derive threshold.

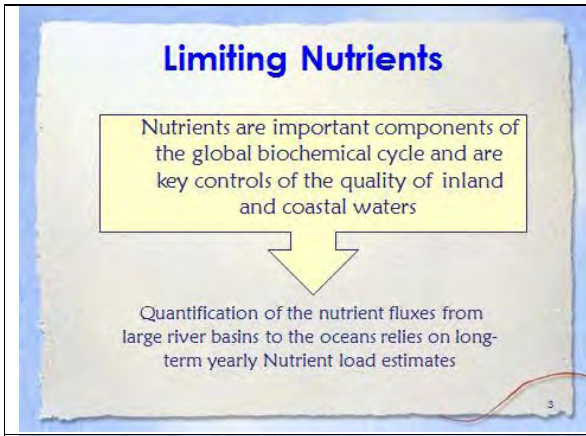
Consultation workshop -4-7th February 2013

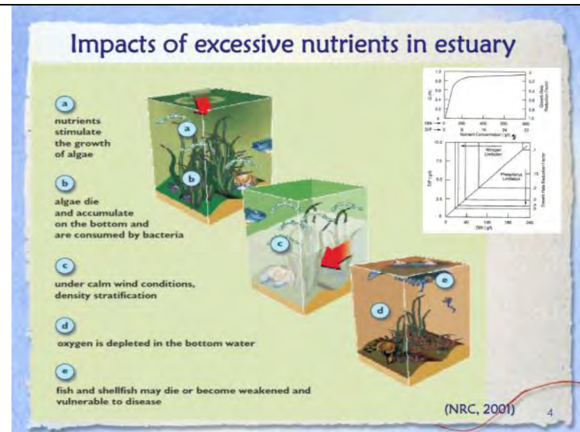
Multi stakeholder workshop

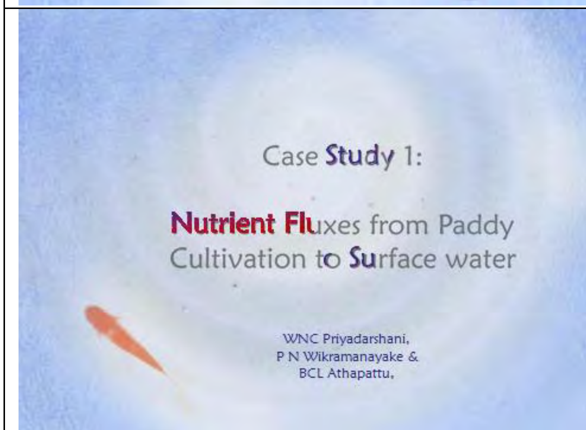


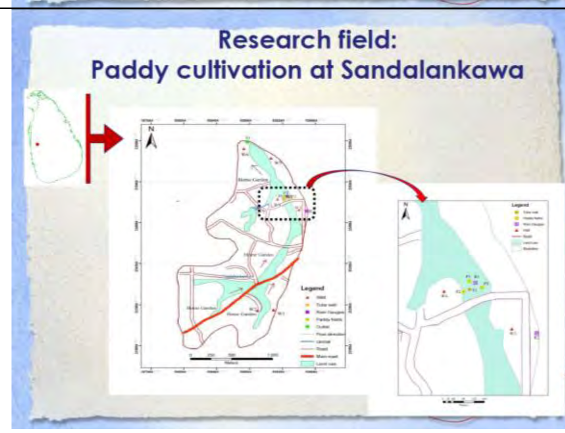
- ***Modeling Nutrient Flux to inland and coastal waters***

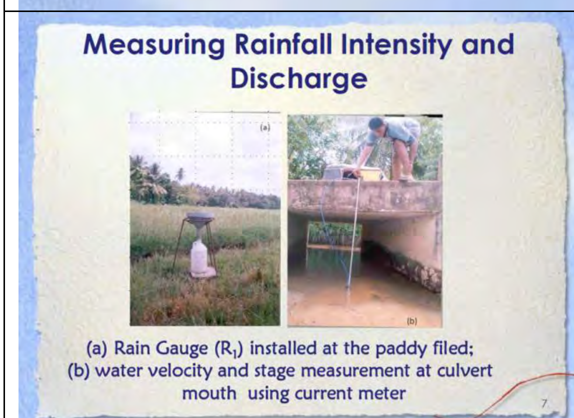


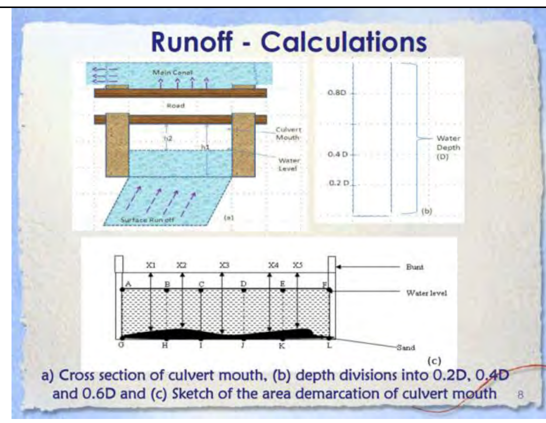

Limiting Nutrients
Nutrients are important components of the global biochemical cycle and are key controls of the quality of inland and coastal waters
Quantification of the nutrient fluxes from large river basins to the oceans relies on long-term yearly Nutrient load estimates
3

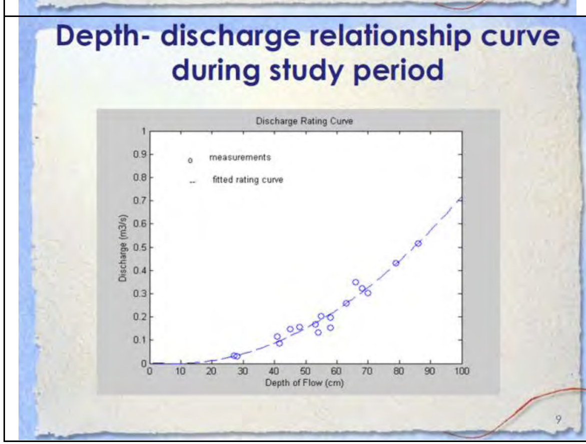

Impacts of excessive nutrients in estuary
a nutrients stimulate the growth of algae
b algae die and accumulate on the bottom and are consumed by bacteria
c under calm wind conditions, density stratification
d oxygen is depleted in the bottom water
e fish and shellfish may die or become weakened and vulnerable to disease
(NRC, 2001)
4

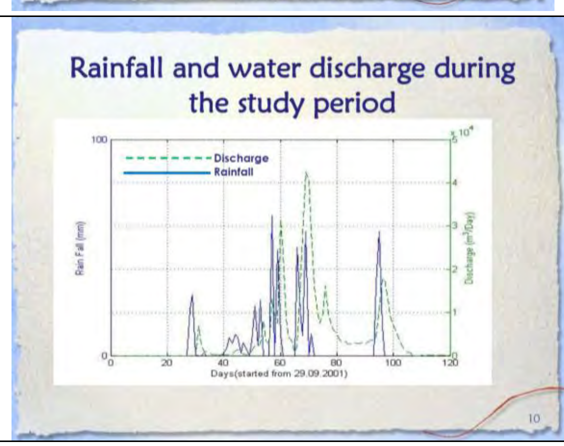

Case Study 1:
Nutrient Fluxes from Paddy Cultivation to Surface water
WNC Priyadarshani,
P N Wikramanayake &
BCL Athapattu,


Research field:
Paddy cultivation at Sandalankawa
Legend

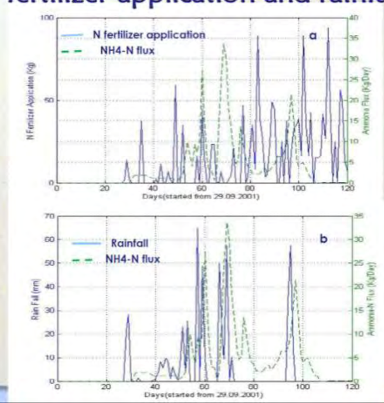

Measuring Rainfall Intensity and Discharge
(a)
(b)
(a) Rain Gauge (R1) installed at the paddy filed;
(b) water velocity and stage measurement at culvert mouth using current meter
7


Runoff - Calculations
Main Canal
Road
Culvert Mouth
Water Level
Surface Run off
0.8D
0.4 D
0.2 D
Water Depth (D)
Bund
Water level
Sand
a) Cross section of culvert mouth, (b) depth divisions into 0.2D, 0.4D and 0.6D and (c) Sketch of the area demarcation of culvert mouth
8


Depth- discharge relationship curve during study period
Discharge Rating Curve
measurements
fitted rating curve
Discharge (m3/s)
Depth of Flow (cm)
9

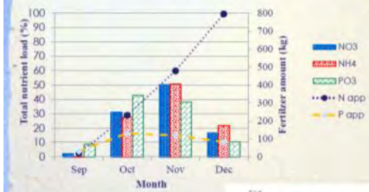

Rainfall and water discharge during the study period
Discharge
Rainfall
Rain Fall (mm)
Discharge (m3/Day)
Days(started from 29.09.2001)
10

NH_4-N fluxes with relation to nitrogen fertilizer application and rainfall



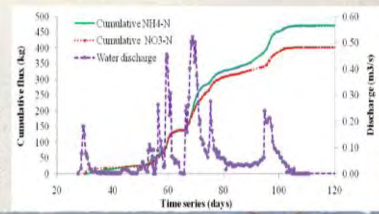
11

Cumulative Nutrient Fluxes

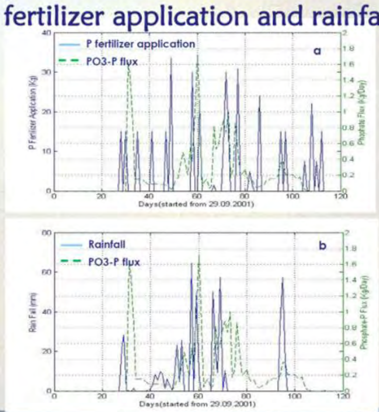


Monthly variations of percentages of Cumulative Nutrient Fluxes

High losses of nutrients occurred during heavy rains due to paddy fields flooding

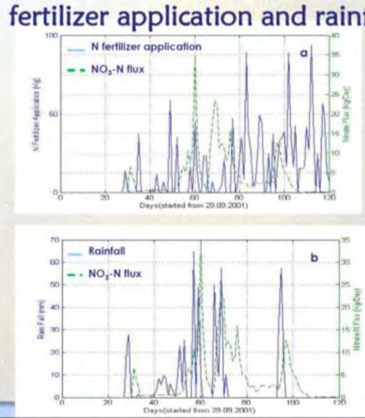


PO_3-P fluxes with relation to nitrogen fertilizer application and rainfall



13

NO_3-N fluxes with relation to nitrogen fertilizer application and rainfall



14

Wrapping up .....

- The study verify that the source of high nitrogen flux in rivers is the runoff of artificial fertilizer.
- The losses of nitrogen from rain fed paddy cultivation are 50% as Nitrate and Ammonia and the total loss of phosphorus is 56%.
- The results have significant implications for the control of eutrophication in coastal aquatic systems
- Simulation models are needed to predict the nutrient runoff to avoid inland and coastal water pollution by nutrients

15

Modelling of several scenarious of the change of water environment using the existing climate change scenarious for Sri Lanka

TASKS

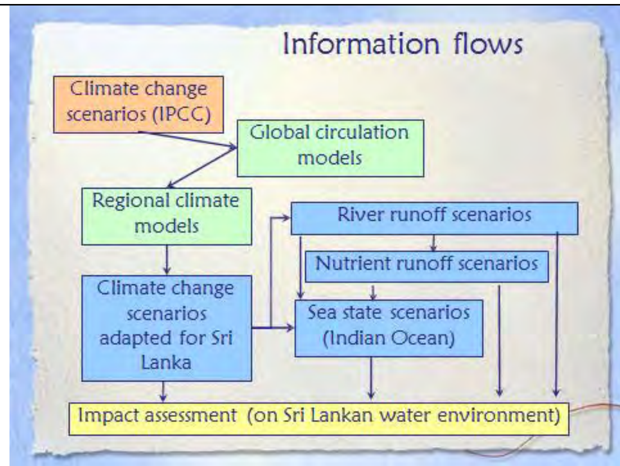
1. Evaluate and adapt the results from the regional climate models and design the series of data which form the state of the water objects.

a. Modeling of surface water and nutrients runoff. Preparation of data series of river runoff for climate change scenarios

b. Calculation of data series of nutrient runoff to the Indian Ocean

Where? Why, Model?

17



Case Study 2

Impact of the Climate Change on Runoff of Kanakarayan Aru in Northern Province

P Kamalraj, BCL Athapattu & Adrian Butler,
Department of Civil and Environmental Engineering
Imperial College London

Introduction

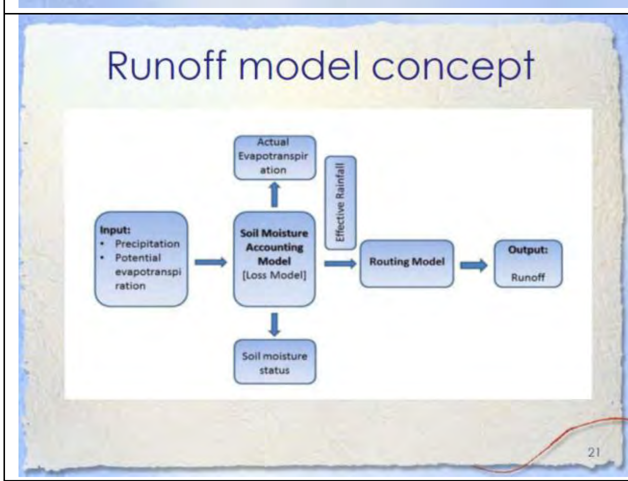
Kanakarayan Aru basin

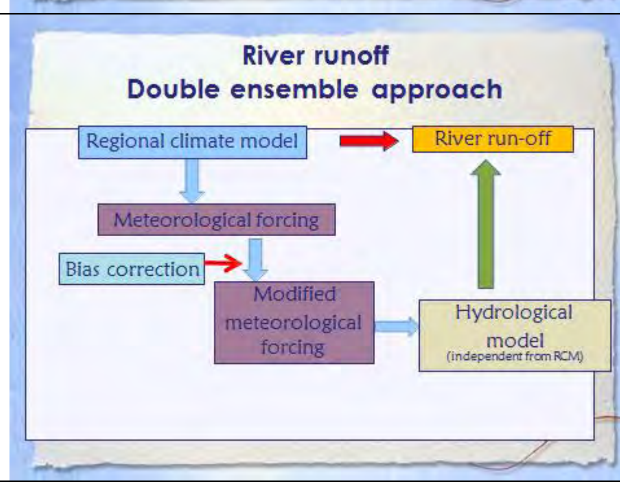
OBJECTIVES:

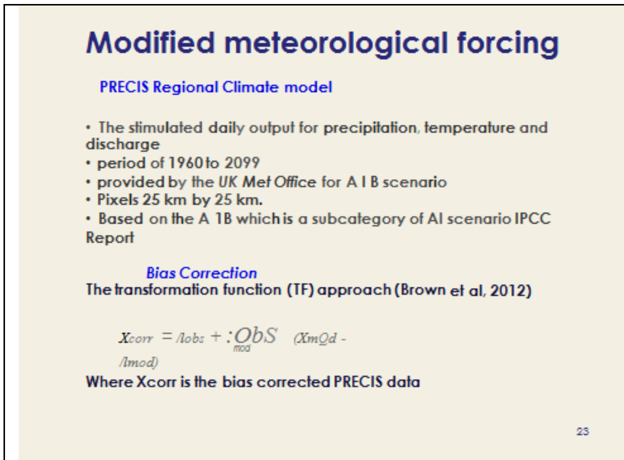
•To build a rainfall runoff model using the available meteorological data, soil ancillary data from Northern Sri Lanka

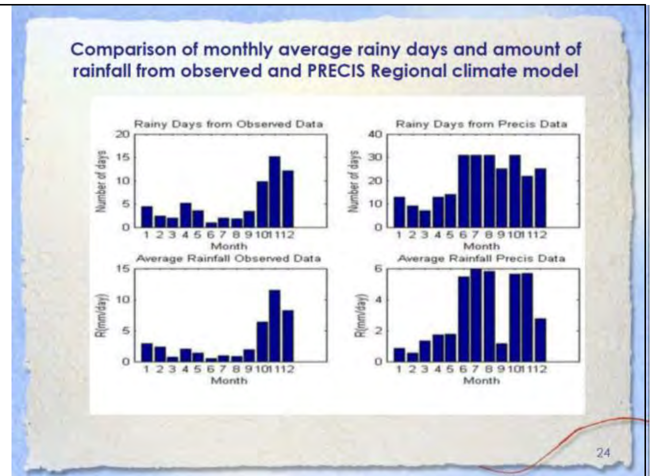
•To predict precipitation and rainfall runoff rates due to climate change and thereby the impact on the water resource on Kanakarayan Aru basin

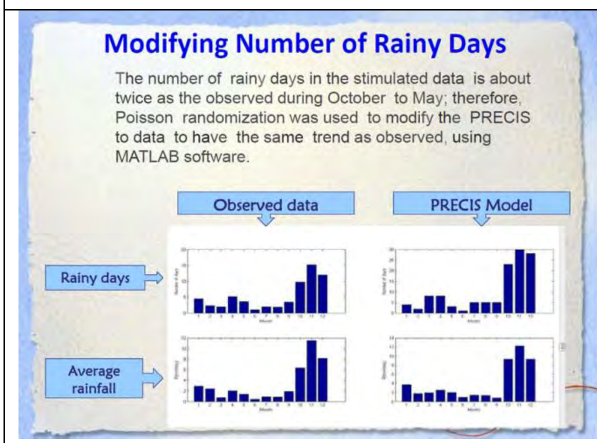
20

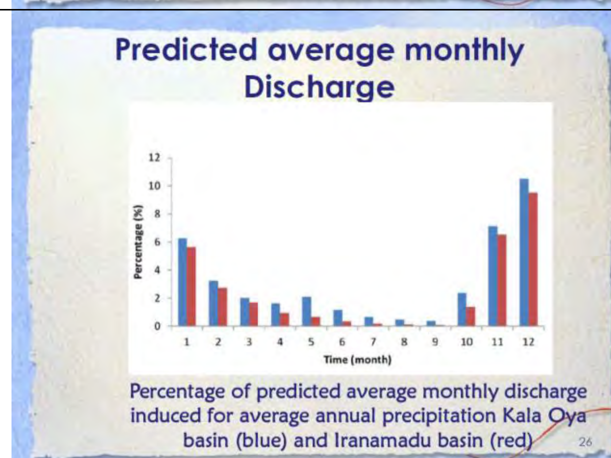


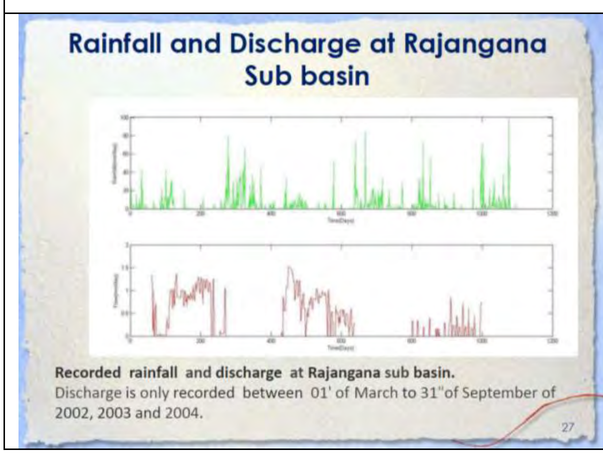


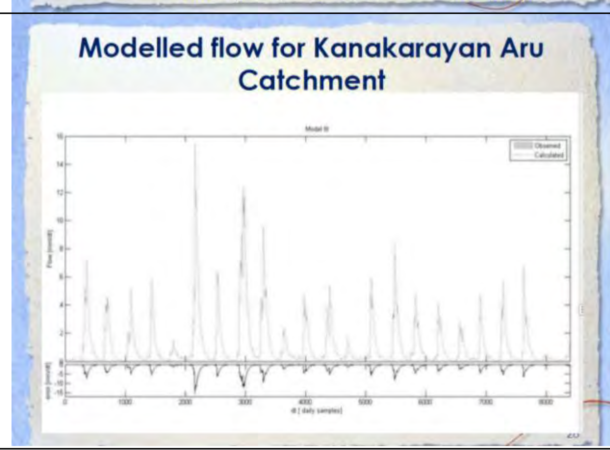

Modified meteorological forcing
PRECIS Regional Climate model
• The stimulated daily output for precipitation, temperature and discharge
• period of 1960 to 2099
• provided by the UK Met Office for A I B scenario
• Pixels 25 km by 25 km.
• Based on the A 1B which is a subcategory of AI scenario IPCC Report
Bias Correction
The transformation function (TF) approach (Brown et al, 2012)
Xcorr = Λobs + :ObS (XmQd - Λmod)
Where Xcorr is the bias corrected PRECIS data
23

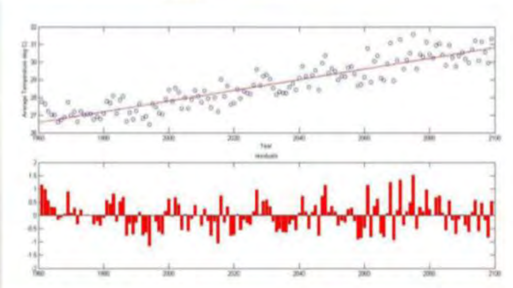

Comparison of monthly average rainy days and amount of rainfall from observed and PRECIS Regional climate model
Rainy Days from Observed Data
Rainy Days from Precis Data
Number of days
Month
Average Rainfall Observed Data
Average Rainfall Precis Data
R(mm/day)
24


Modifying Number of Rainy Days
The number of rainy days in the stimulated data is about twice as the observed during October to May; therefore, Poisson randomization was used to modify the PRECIS to data to have the same trend as observed, using MATLAB software.
Observed data
PRECIS Model
Rainy days
Average rainfall

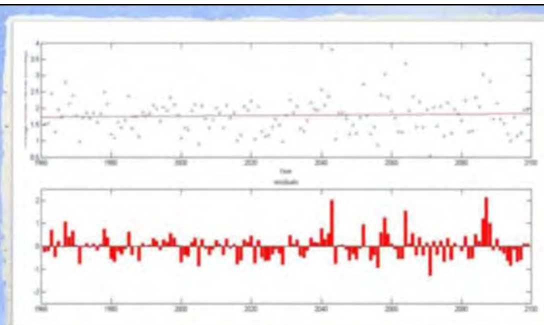

Predicted average monthly Discharge
Percentage (%)
Time (month)
Percentage of predicted average monthly discharge induced for average annual precipitation Kala Oya basin (blue) and Iranamadu basin (red)
26


Rainfall and Discharge at Rajangana Sub basin
Recorded rainfall and discharge at Rajangana sub basin.
Discharge is only recorded between 01' of March to 31"of September of 2002, 2003 and 2004.
27


Modelled flow for Kanakarayan Aru Catchment

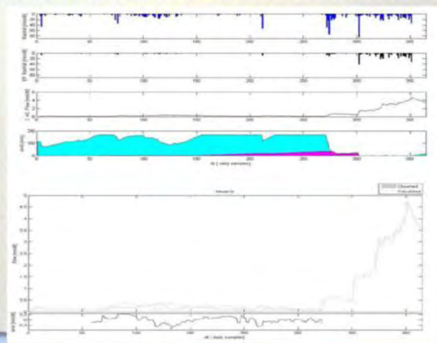


Annual mean temperature and liner fit with R^2 of 0.83 PRECISE simulation for 1960 to 2099 (b) residual between the actual value and the linear fit

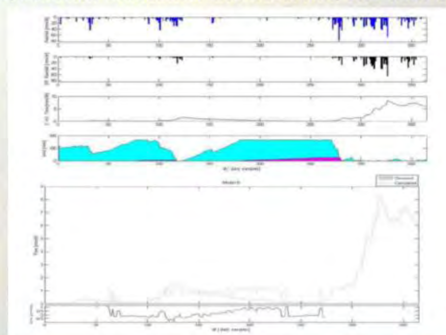


Annual Rain fall and liner fit with R^2 of 0.02 PRECISE simulation for 1960 to 2099 (b) residual between the actual value and the linear fit

The RRMT model output for the validation period: 01-01-2003 to 31-12-2003 [Top: The precipitation, the flow rate (both estimated and observed) and soil moisture deficit plots; Bottom: Calculated and observed, and their errors.



The RRMT model output for the calibration period: 01-01-2002 to 31-12-2002 [Top: The precipitation, the flow rate (both estimated and observed) and soil moisture deficit plots; Bottom: Calculated and observed, and their errors.

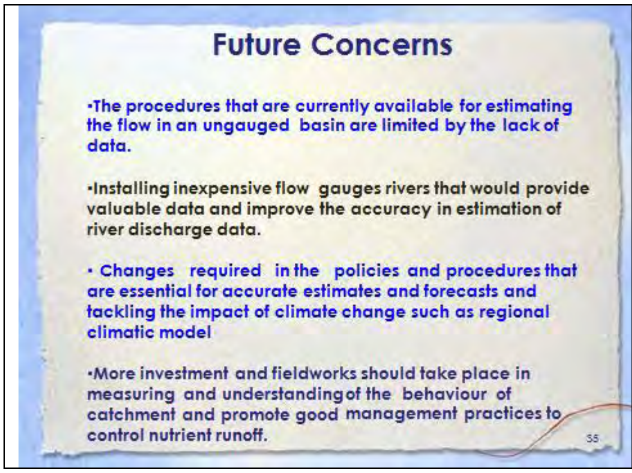


Summary of output from climate change data through rainfall runoff modelling

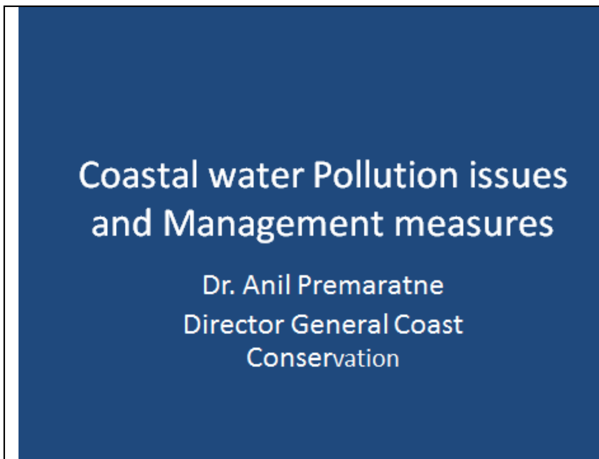
Period	Annual Average Precipitation (bias corrected)	Annual water availability	Run off ratio	Temperature (bias corrected)
	(mm)	(mcm)	(%)	(° C)
1960 to 1990	1386	276	22	25.4
1990 to 2020	1388	253	20	25.9
2020 to 2050	1361	200	16	27.0
2050 to 2070	1510	214	16	27.9
2070 to 2099	1431	149	12	29.4

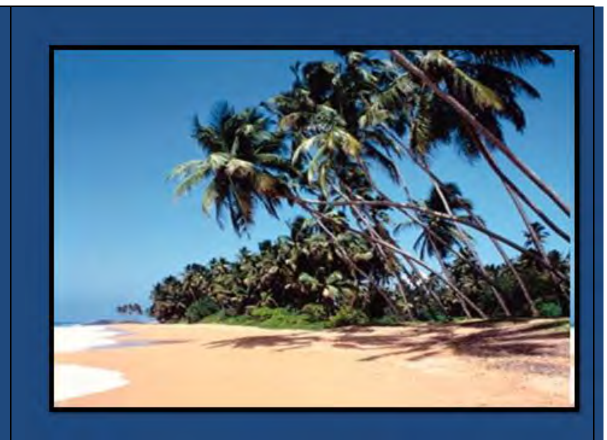
Conclusions

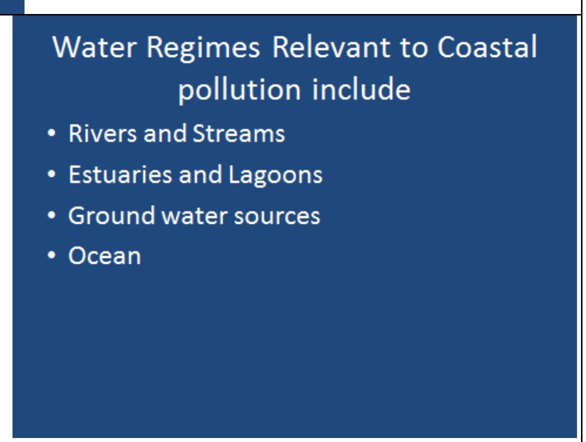
- The mean annual surface water availability in the Kanakaraya n Aru basi n is estimated to be 289 million ubic meters (mcm).
- This represents 28% of the mean a1mual catchment rainfall of 1034 mm, which was estimated from a single gauge in Iranamadu during the study period.
- Comparing this result with model simulations obtained using regional rainfall and temperature (PRECIS) data, derived from the UK Met Office HadCM3 climate model for the same time period, gave the availability lity as 276 mcm.



- ***Coastal water Pollution issues and Management measures***







Rivers and Streams

- There are 105 rivers and streams discharge water to the sea through Coastal zone
- Significant sources of the river pollution are sewage, Industrial effluent and Agricultural runoff

Estuaries and Lagoons

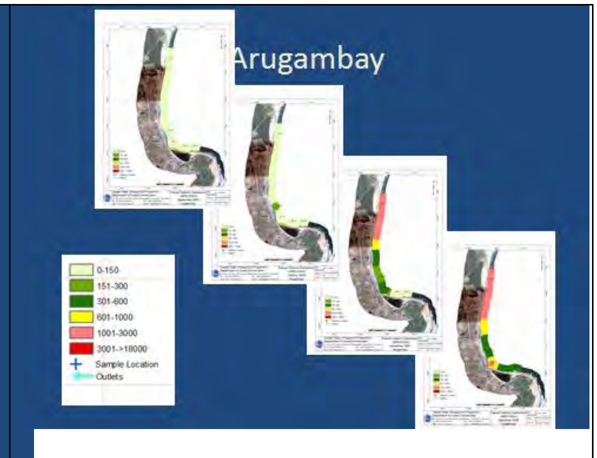
- There are 158,000 ha of estuaries and lagoons in Sri Lanka
- Many lagoons and estuaries are exposed to discharges of sewage, pesticides and waste water high at some locations
- Studies conducted on the Negambo Lagoon indicate that coliform bacteria counts were unacceptable

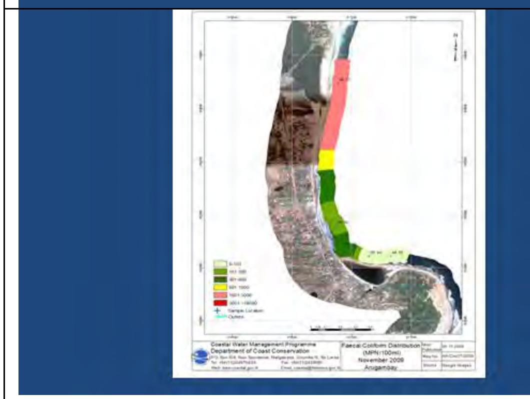
Ground Water

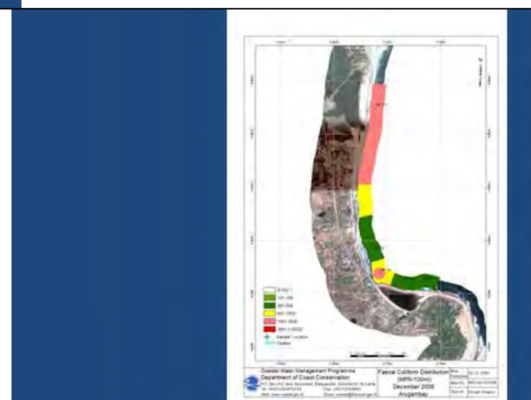
- Increasingly used for drinking
- Estimated ground water potential for the country is 780,000 ha/meter per annum.
- Most serious threats to coastal ground water come from nitrate and bacterial contamination

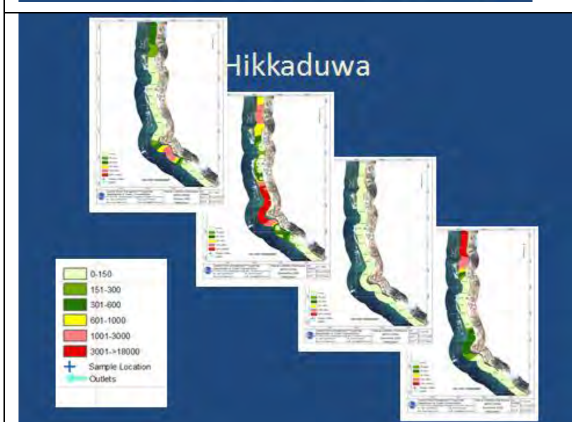
Ocean

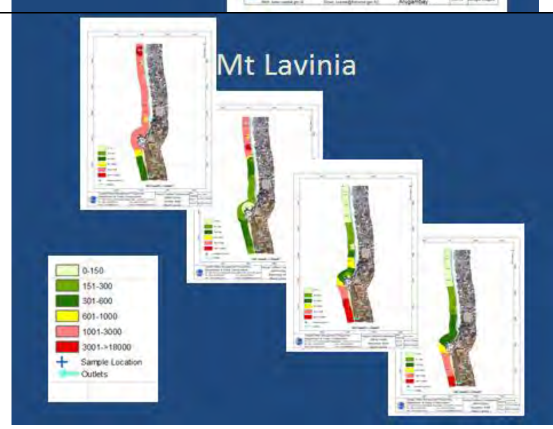
- Main sources of ocean pollution are industry , agriculture and tourism.

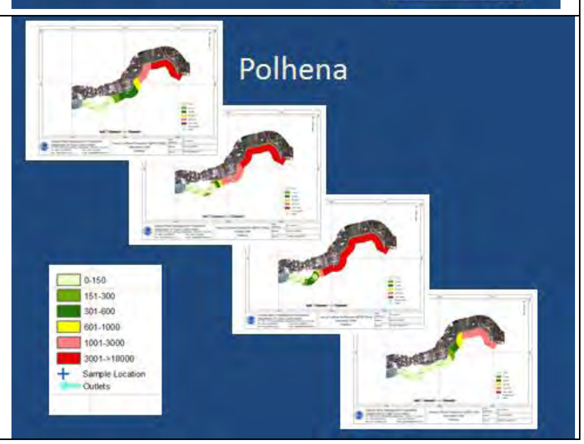












Enrichment with nutrients such as nitrogen and phosphorus

Key Sources in the Coastal area

- Municipal domestic sewage
- Industries
- Agriculture and aquaculture
- Squatter settlements

Adverse Impacts

- Affects the growth of marine Flora and fauna
- Stimulates algal growth
- Causes change or decline biodiversity
- Change water quality
- Affects growth and reproduction of marine fauna
- Bio-accumulation of substance decline of biodiversity

Agriculture waste

- The annual level of chemical fertilizer use in Sri Lanka is estimated to be 77kg/ha
- This is two to eight times more than in other Asian countries
- Annual average use of pesticides in Sri Lanka is between 1,200 and 1,600 grams per hectare.
- over half of the farmers use at least twice the recommended dosage

Agencies Responsible for Coastal Pollution control in Sri Lanka

- CEA under National Environmental Act No. 47 of 1080 amended by Act no 56 of 1988
- CCD Coast Conservation Act No. 57 of 1981 amended by Act. No. 64 of 1988 and Act No of 2011
- Local Authorities (Local Government by-laws)
- Marine Environment Prevention Authority
- Water Supply and Drainage Boards

Central Environmental Authority Function

- Investigate the cause, nature, extent and prevention of pollution
- Promote Research
- Set standards, norms and criteria to maintain the quality of the environment
- Coordinate all regulatory activities for the discharge of waste and pollutants
- Recommendations, directives to local authorities

Management Mechanism

- Implement Environmental standards
- EIA and IEE
- Prohibitions
- Issue of EPL
- Research
- Coordination
- Appointment of Committees

CCD Function

- Control development activities which may create pollution in the Coastal Zone

Prevention or Intrusion of waste or foreign matter into the Coastal Zone

- Section 25(1)

- Where the Director General finds that the quality of the water in the coastal zone or the stability of the coastal zone or resources within the Coastal Zone is being adversely affected by the intrusion of any waste or foreign matter of by physical activity

he shall.

(a) If the source of such waste or foreign matter is within the coastal zone or if such activity lies within the coastal zone, require, by notice in writing, the person responsible therefore to take such corrective measures as are specified in such notice or to desist from such activity; and

(b) If the source of such waste or foreign matter or if such activity is not within the coastal zone, request the appropriate local authority or agency to take such measures as may be necessary to prevent such intrusion or activity.

After the period specified has elapsed , take such measurers as may necessary to prevent such activity , shall be recovered from the person on whom notice served, as debt due to the state.

- Failure to comply with such notice is an offence under Section 29(1) (a).

Management Mechanism

- Permit procedure
- Guidelines
- IEE and EIA
- Public Education
- Coordination

MEPA Function

- Prevention, reduction and control of pollution in Sri Lanka waters
- Effect international conventions for the prevention of pollution of the sea

Management Mechanism

- Prevention of marine pollution from land base sources
- Oil spell contingency plan and prevention

Policies adopted by the CCD to control the Coastal Pollution

- Require that all development activities in the coastal zone comply with the CEA's standards for stipulated coastal and marine waters
- Cooperate with other agencies in developing strategies for providing economic incentives to developers to minimize untreated discharges into the coastal waterways
- Assist relevant agencies in establishing a single pollution abatement fund

Environmental Issues

- Degradation of the Coastal habitats
- Reduction and changes of Coastal biodiversity
- Changes of Coastal water quality

Institutional issues

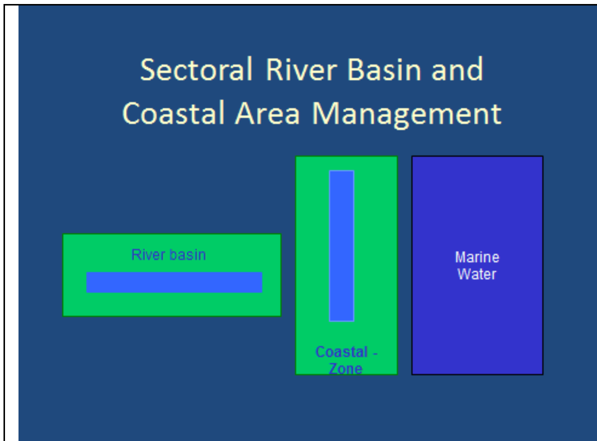
- Lack of inter-agency coordination
- Lack of Integrated management system
- Poor implementation of existing laws & regulations
- Lack of single agency responsible for entire river basin management
- Lack of continuous Monitoring mechanism

Social Issues

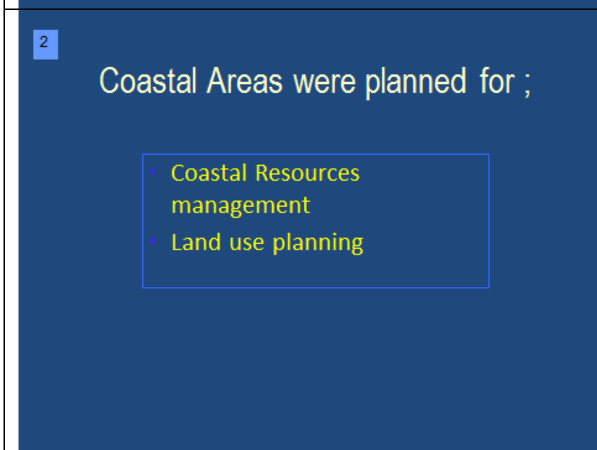
- Loss of Food security for the Coastal communities
- Lost of Income sources of the artisanal fishermen
- User conflicts among the fishermen and the agriculture farmers
- Problem with drinking water

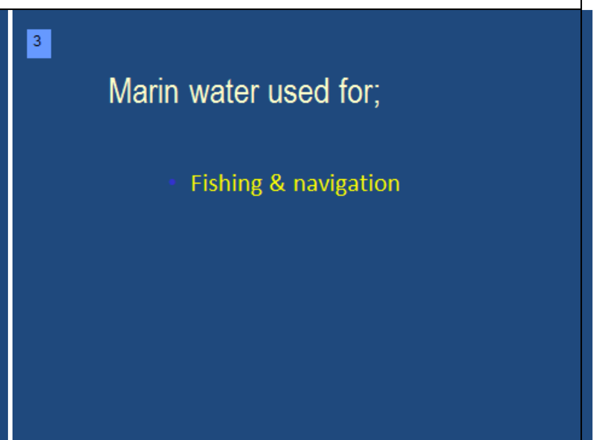
Management Solution

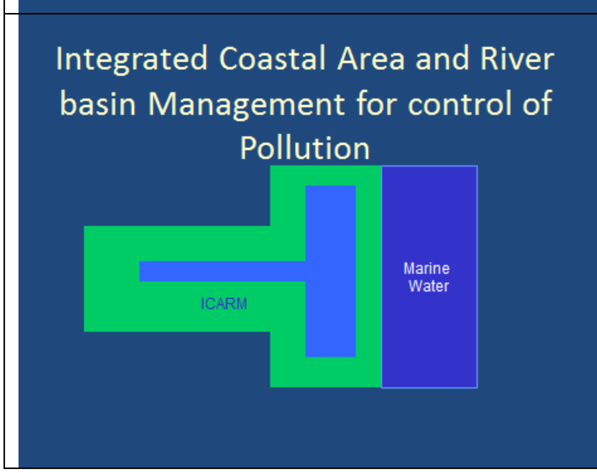
- Introduction of Integrated Coastal pollution prevention mechanism
- Establishing an Agency for River basin management
- Implementation of strong Environmental Education program on organic farming methods to minimize the chemical fertilizer uses


Sectoral River Basin and
Coastal Area Management
River basin
Coastal - Zone
Marine Water

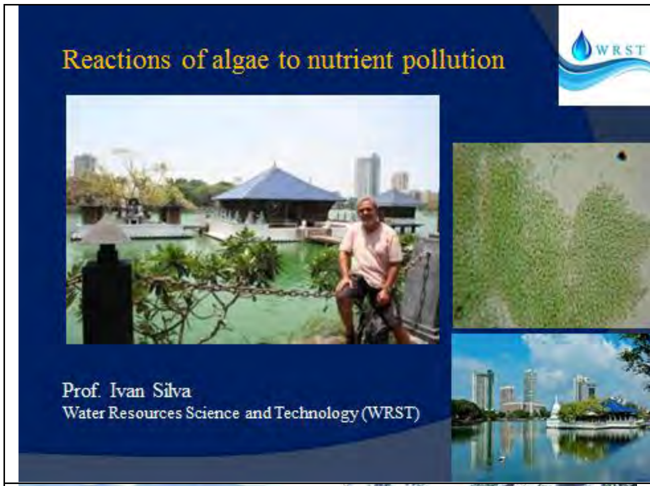

1
River management focused on;
Flood control
Water supply & Irrigation
However, little consideration has been given to;
• Conservation and Management of the Environment and Pollution

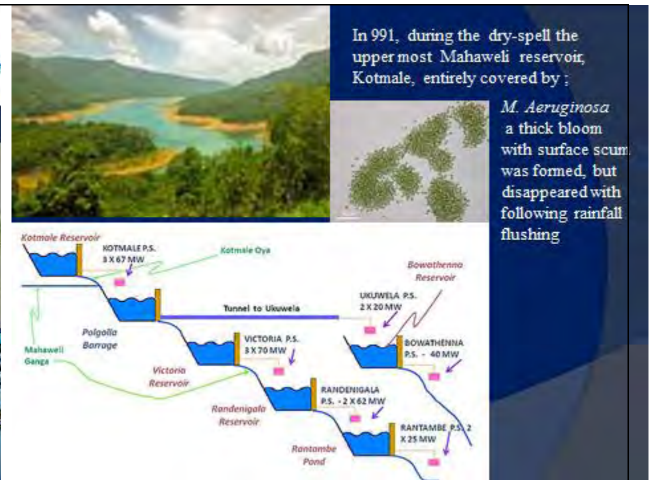

2
Coastal Areas were planned for ;
Coastal Resources management
Land use planning

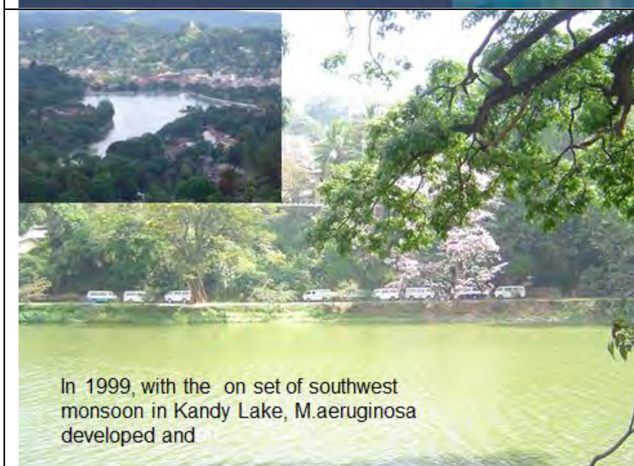

3
Marin water used for;
Fishing & navigation

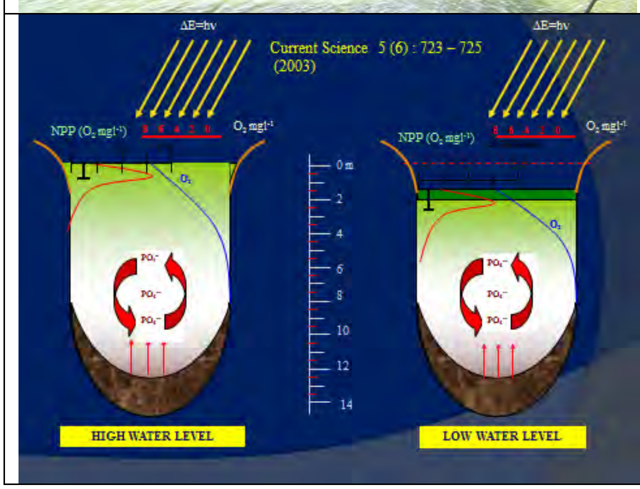

Integrated Coastal Area and River basin Management for control of Pollution
ICARM
Marine Water

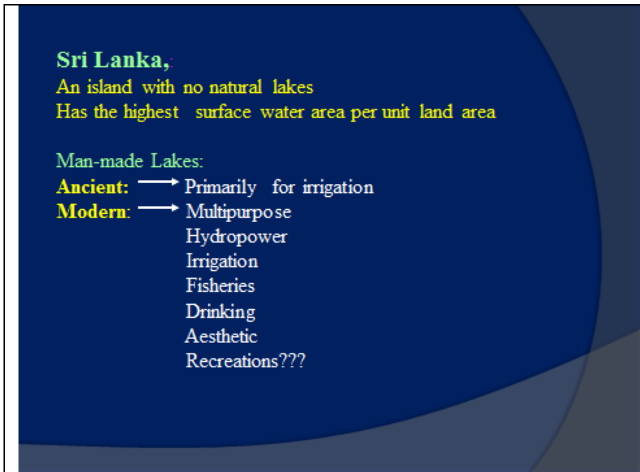
- ***Reactions of algae to nutrient pollution***

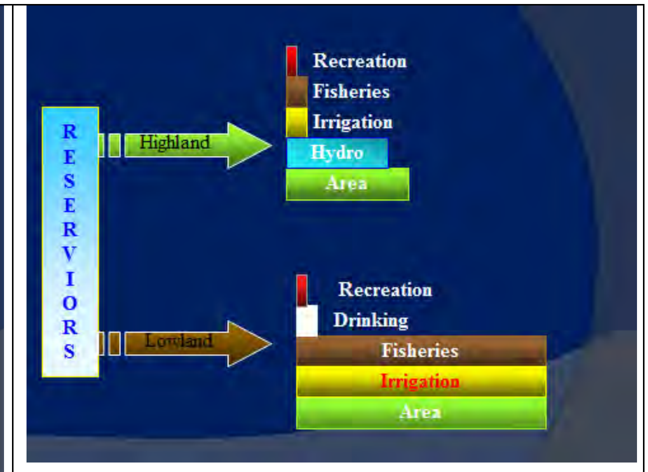


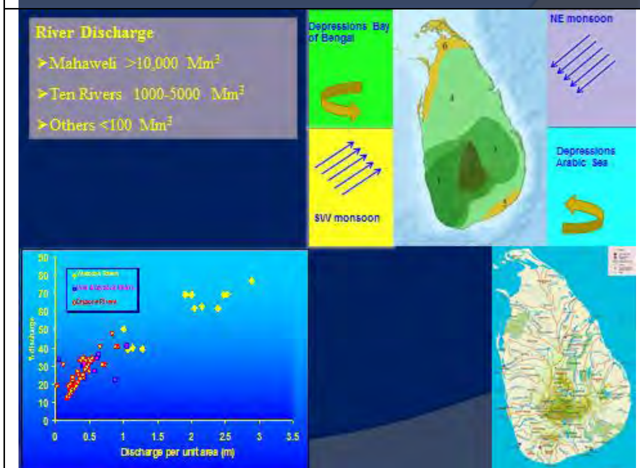


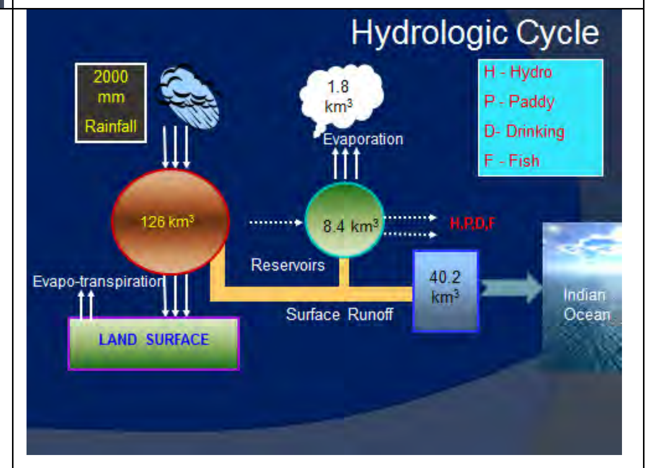


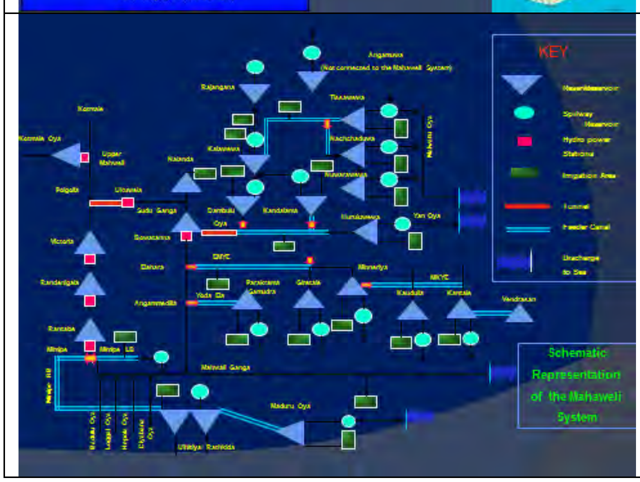


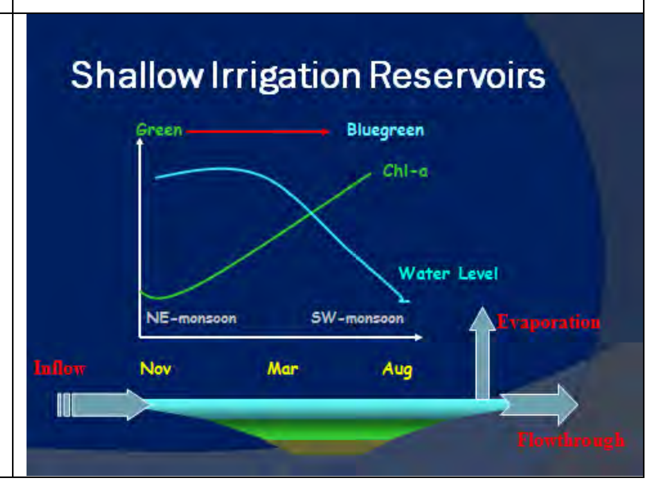

Sri Lanka,
An island with no natural lakes
Has the highest surface water area per unit land area
Man-made Lakes:
Ancient: Primarily for irrigation
Modern: Multipurpose
Hydropower
Irrigation
Fisheries
Drinking
Aesthetic
Recreations???

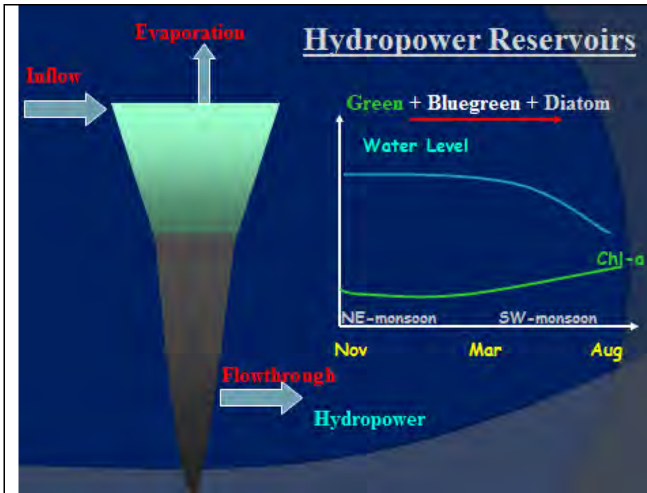

RESERVIORS
Highland
Recreation
Fisheries
Irrigation
Hydro
Area
Lowland
Recreation
Drinking
Fisheries
Irrigation
Area

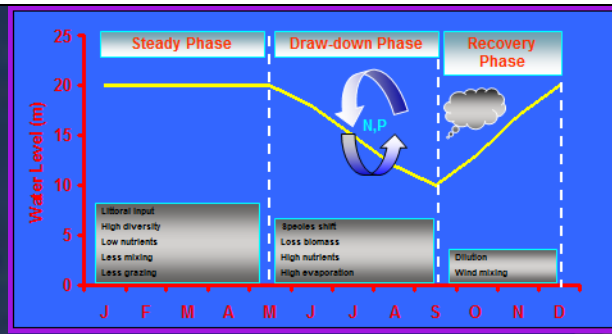

River Discharge
➤Mahaweli >10,000 Mm^3
➤Ten Rivers 1000-5000 Mm^3
➤Others <100 Mm^3
Depressions Bay of Bengal
NE monsoon
SW monsoon
Depressions Arabic Sea
Discharge per unit area (m)


Hydrologic Cycle
2000 mm Rainfall
1.8 km^3
Evaporation
H - Hydro
P - Paddy
D- Drinking
F - Fish
126 km^3
8.4 km^3
H,P,D,F
Reservoirs
Evapo-transpiration
Surface Runoff
40.2 km^3
Indian Ocean
LAND SURFACE


KEY
Schematic Representation of the Mahaweli System


Shallow Irrigation Reservoirs
Green
Bluegreen
Chl-a
Water Level
NE-monsoon
SW-monsoon
Evaporation
Inflow
Nov
Mar
Aug
Flowthrough





Water quality decides plankton composition during the steady state

N:P decides dominant taxonomic group during the draw-down phase

High N:P ratio non-nitrogen fixing taxa (*Microcystis aruginosa*)

Low N:P ratio nitrogen fixing tax (*Cylindrospermorpsis raciborskii*)

High TP biomass

Why nitrogen limitation in dry zone reservoirs?

Natural Levels of Nutrients

TP < 100 µg l^{-1} **DP < 25 µg l^{-1}**

DSi 2-10 mg l^{-1}

TN ??? Concentrations are low in tropical waters

Redfield Ratio
C:N:P = 106:16:1

N:P : 16:1 — ↑ P-limiting / ↓ N-limiting

Nitrogen limitation in tropical lakes and reservoirs (Lewis 2002)

Latitudinal difference in N-cycles ???

-Low external supply of N in tropical lakes**

-High internal loss of nitrogen in tropical lakes

** very unlikely, therefore attention can be focused on internal losses

The most likely mechanisms in internal losses is de-nitrification, which has the potential to alter N/P ratio (Steitzinger 1988)

De-nitrification is the reduction of NO_2-N and NO_3-N into N_2 and encompasses that can produce intermediate by products including N_2O

De-nitrification in aquatic ecosystems is processes of conversion of biologically available nitrogen species into biologically non-available form (N_2)

De-nitrification may occur in Lake sediments even when overlying water contains oxygen is less than 4mg l^{-1}

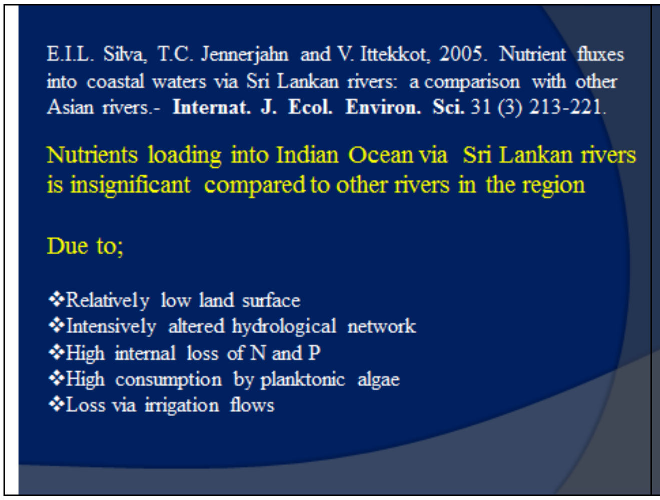
Denitification in the water (interface water) is driven by **nitrification** at oxi-microsites where NH_3 is converted into NO_3 -

Under anoxic conditions superficial sediment loss nitrate rapidly and microbial de-nitrification occur

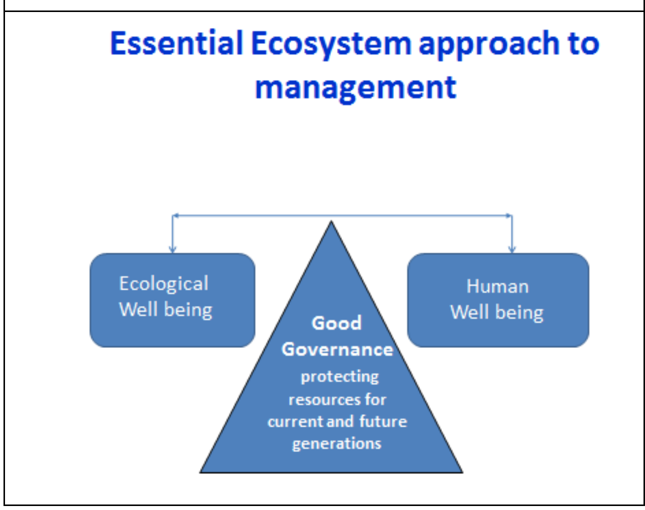
Conditions favourable for de-nitrification may be more probable in tropical lakes than in temperate lakes

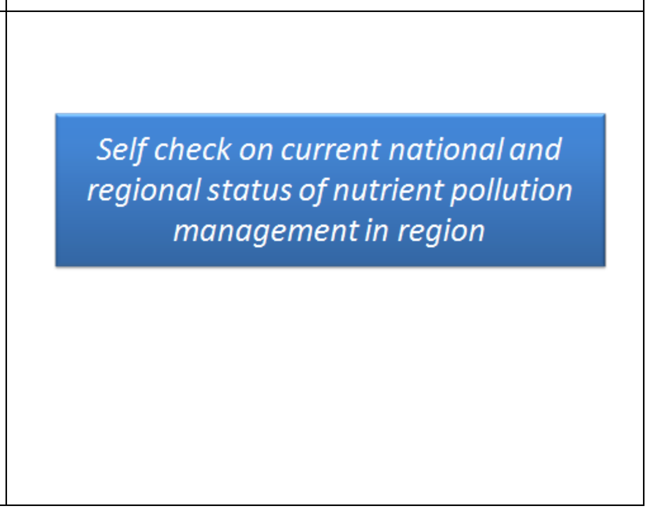
Latitudinal gradient in hypolimnetic temperature is the primary cause of major difference in de-nitrification potential

There is an excess amount of nitrogen species in wet zone water bodies receiving urban drainage, when bottom is anoxic reactive phosphorous is mobilized, facilitating blooming non-nitrogen fixing cyanobacteria



Annex 4.7. Group Work Presentations





Principles of EAM

- **Good governance**
- **Appropriate scale** – takes into account the connections within and across ecosystems and social systems
- **Increased participation**- all key stakeholders in
- **Multiple objectives** – objectives that address multiple challenges

- **Corporation and coordination** - between agencies and society
- **Adaptive management** – embrace changes through learning and adapting
- **Precautionary approach** – use precautions when uncertainty prevails

Task 1

Self check for your country

5 minutes

Principles	1	2	3	4	5
1. Good governance					
Notes					
1. Appropriate scale					
Notes					
1. Increased participation					
Notes					
1. Multiple objectives					
Notes					
1. Cooperation and coordination					
Notes					
1. Adaptive management					
Notes					
1. Precautionary approach					
Notes					

Principles	1	2	3	4	5
1. Good governance					
Notes					
1. Appropriate scale					
Notes					
1. Increased participation					
Notes					
1. Multiple objectives					
Notes					
1. Cooperation and coordination					
Notes					
1. Adaptive management					
Notes					
1. Precautionary approach					
Notes					

Task 2

Self check for region

10 minutes discussion

Principles	1	2	3	4	5
1. Good governance					
Notes					
1. Appropriate scale					
Notes					
1. Increased participation					
Notes					
1. Multiple objectives					
Notes					
1. Cooperation and coordination					
Notes					
1. Adaptive management					
Notes					
1. Precautionary approach					
Notes					

Identification of *national and regional* challenges and opportunities for nutrient pollution management

Task 3

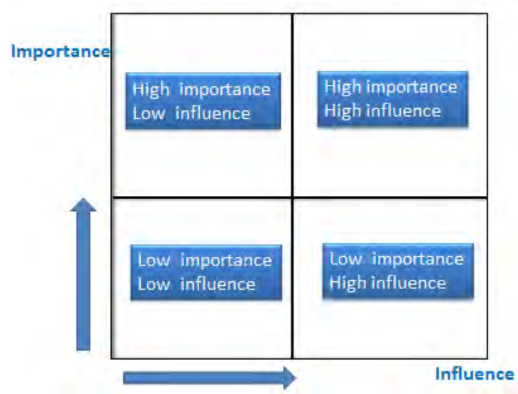
- What are challenges faced in dealing with nutrient pollution management?
- What are the opportunities available in the country/ region to deal with nutrient pollution management?

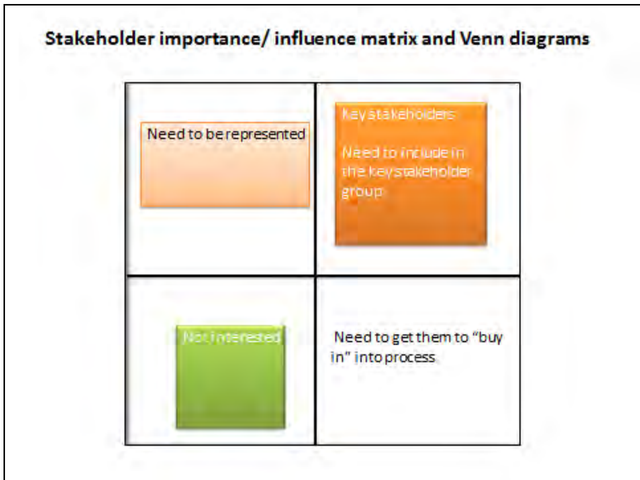
10 minutes

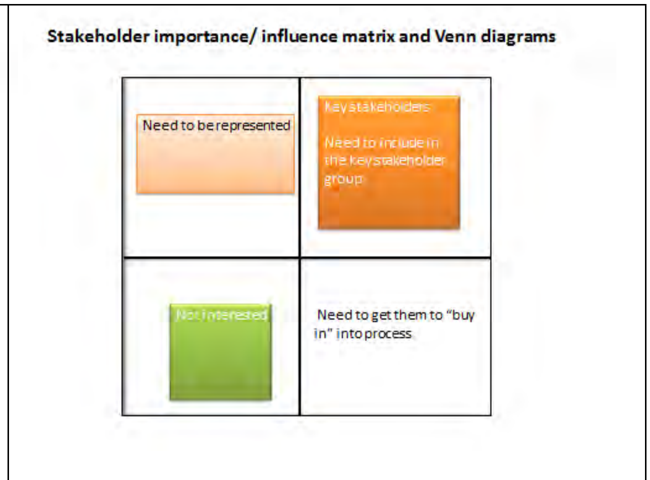
Stakeholder listing

- Who are the stakeholders?
- How are they connected?
  - Legal
  - Social
  - Trade
  - Other

Stakeholder importance/ influence matrix and Venn diagrams







Vision

South Asian seas free of nutrient pollution

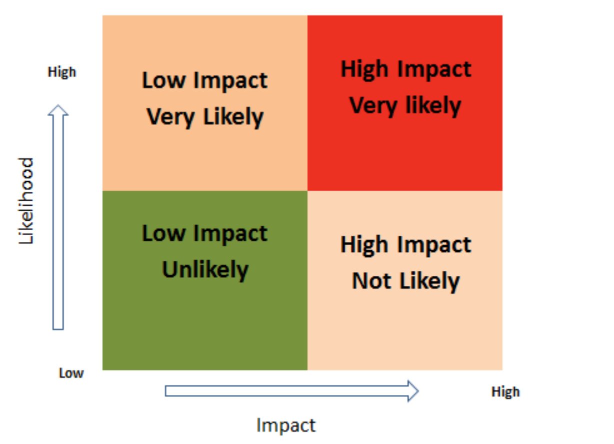
Aichi biodiversity – Target 8

By 2020, pollution including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity

Causal chain analysis

- **Driver** — Increasing human population
- **Root cause (threat)** — Open access to water
- **Proximate cause(threat)** — Excess amounts of feed used in shrimp aquaculture
- **Issue** — Algal blooms/ increased orthophospate levels

Selecting the threats to be addressed through E- EAM



Developing the plan

- Vision
- Goal
- Objectives
- Management Action 1/2/3……….

Goal

- the long term outcome that management is striving to achieve
  - Restored and improved sewage management systems for South Asia

Objective

- Clear, measurable, action oriented targets to achieve the goals

Action plan

- An agreed and coherent set of management actions that address the issues and meet the objectives

Formalizing the E-EAM plan

- Formal legal approvals?
- Adoption?
- Implementing agency/agencies?
- Agencies to facilitate ?
  - Capacity development?
  - Communication?

Co- management and financing

- Set actions to obtain the consent and participation from key stakeholders?
- Plan for finance?

Communication

Target audience	Communication method	Key Messages	Timing

Monitoring

- Within country?
- Within region?