



सत्यमेव जयते
गुजरात सरकार



Gulf of Kachchh

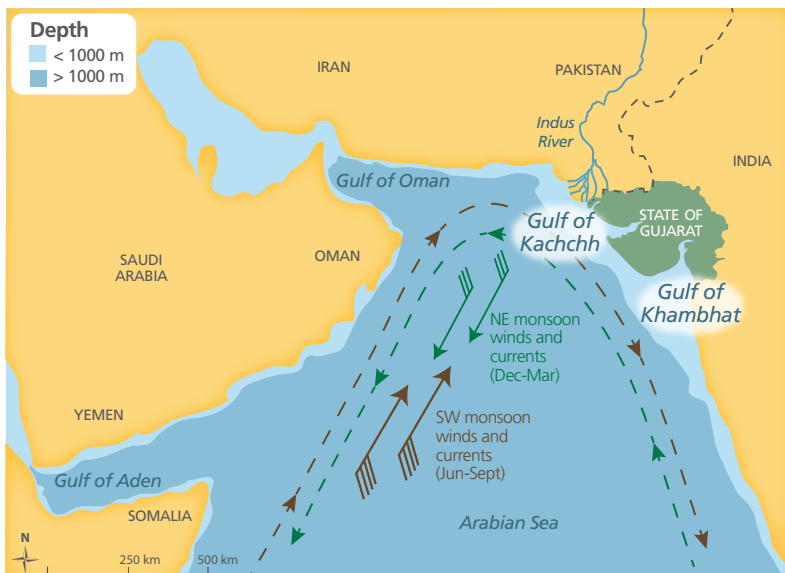
A Framework for the Cumulative Environmental Impact Assessment

State of Gujarat, India

2014



Gujarat Ecology Commission
Gandhinagar



Influence of Arabian Sea

The Indus River drains the western Himalaya and Karakoram Mountains, crossing the semi-arid to arid regions of the Indus Plain toward the Arabian Sea further north of Gulf of Kachchh. River Indus discharging 200 million tons of sediments annually. Although this discharge was modest compared to other rivers with drainage basins of similar size, the Indus used to be one of the most important sediment-producing rivers in the world that built an extensive alluvial plain and delta as well as the world's second largest submarine fan. During the SW monsoon, the hydrography being alongshore is favourable for the dispersal of flux of the Indus into this region, which has peak discharge during this time. It is inferred, therefore, that the terrigenous flux of the Indus is transported along shelf by the SW monsoon hydrography as reflected in the higher deposition of the clays of the Indus on the inner shelf region of the Gulf of Kachchh.

This document outlines a framework for the Cumulative Environmental Impact Assessment for the Gulf of Kachchh. It was generated following the *Workshop on Cumulative Environmental Impact Assessment of Gulf of Kachchh*, conducted in Gandhinagar, Gujarat, India on 5-6 September, 2013. The Workshop incorporated local expertise (and not quantitative data) about the natural resources and features of the Gulf of Kachchh, the potential pressures affecting them, and current conservation efforts. The Cumulative Environmental Impact Assessment will take several years to complete. This document does not describe the results of the Gulf of Kachchh assessment—rather, it describes a path forward for its completion.

ACKNOWLEDGEMENTS



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organisation representatives, and graduate students from: National Centre for Sustainable Coastal Management (NCSCM), Forest and Environment Department (Government of Gujarat), Gujarat Ecology Commission (GEC), Gujarat Ecological Education and Research Foundation (GEER), Marine National Park-Jamnagar, Gujarat Pollution Control Board, Gujarat Maritime Board, Gujarat Environment Management Institute, Save Ltd, and Bhaskaracharya Institute for Space Applications and Geo-Informatics.

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Developing an Assessment Framework

Sustainability of the Gulf of Kachchh depends on the actions taken now to manage development along the region. Investment and growth are forecasted to continue at unprecedented levels, requiring careful assessment and planning to ensure viability of region from social, economical, and environmental perspectives. Planned growth in the Gulf of Kachchh is largely focused around expansion of existing developments resulting in more intense and widespread impacts. Managing the environmental effects of this growing development requires movement away from activity-specific impact assessments, and transition towards a cumulative impact assessment that investigates the synergistic and/or additive effects of all activities in the Gulf. This document describes the framework for developing such an assessment for the Gulf of Kachchh, which will be based on quantitative data and modelling.

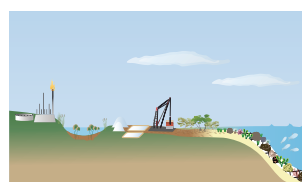
Framework conceptualisation

The assessment framework is divided into a **5-step process** that will lead to improved management planning for the region. An overview of each step, followed by step

recommendations, is provided in this document, including actions and information required to fulfil the Cumulative Environmental Impact Assessment.

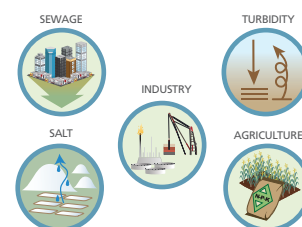
1 KEY FEATURES AND VALUES

Describe the environmental characteristics of the region including the social, economic, and environmental values placed upon them.



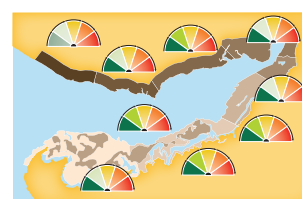
2 MAJOR PRESSURES

Identify and quantify the current and future activities in the region that are, or are likely to, impact the environmental characteristics and values.



3 STATE OF THE ENVIRONMENT

Examine and describe the condition of the existing environment, identify vulnerable areas, and determine the carrying capacity of the system for current and expanded growth.



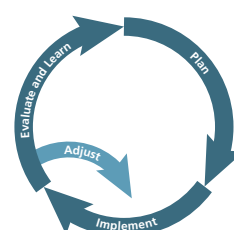
4 LINKING PRESSURES TO IMPACTS

Quantify past and existing pressures and determine linkages to known impacts to enable forecasting of risks associated with future developments.



5 INTEGRATING RESULTS INTO ACTION

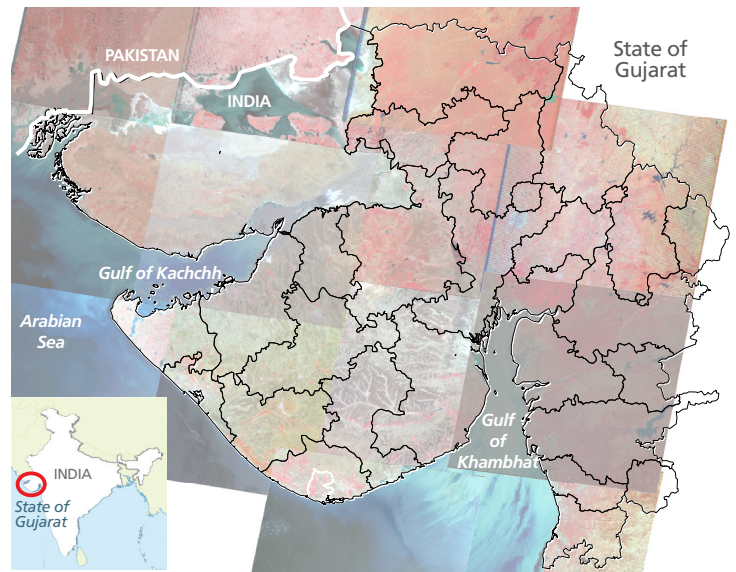
Consolidate and integrate information obtained from Steps 1 – 4 into a regional management plan that includes ongoing monitoring and assessment, continuous review, and adaptive planning.



Step 1: Key Features and Values

1

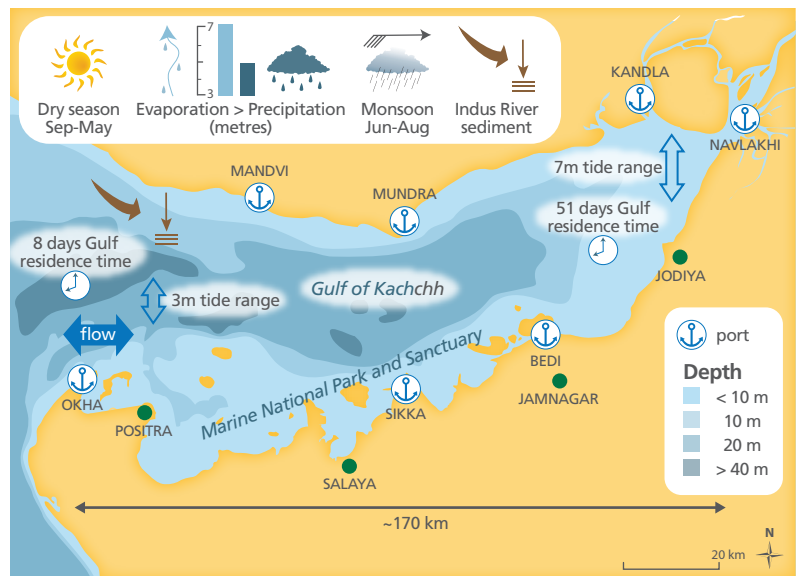
The Gulf of Kachchh is situated between Saurashtra and Kachchh Peninsulas in the western State of Gujarat, India. The Gulf has an east-west orientation and is bordered by Kachchh district to the north, Jamnagar district to the south, Rajkot and Morbi districts to the east, Devbhoomi Dwarka district to the south-west, and the Arabian Sea to the west. A relatively shallow and well mixed water body (average depth 20 m), the Gulf covers an area of 7,350 km², is approximately 170 km long, and up to 75 km wide at its mouth. Its conical structure and shallow inner regions result in tidal variations of approximately 3 m at its mouth and up to 7 m towards the east.



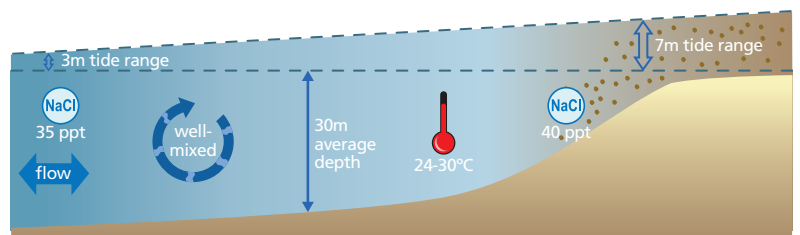
The districts of the State of Gujarat are shown, along with the two gulfs, Kachchh and Khambhat.

Gujarat is a maritime state with a 1660 km long coastline, the longest in India, and two gulfs, the Gulf of Kachchh and the Gulf of Khambhat.

A few rivers drain into the Gulf carrying only a small quantity of freshwater, except during the monsoon. The Banas, Rupen, and Saraswati Rivers annually delivers 140 million m³ of freshwater to the Little Rann of Kachchh during the southwest monsoon period, converting the barren landscape into fishing grounds. During the dry season (September – May), it reverts back to a saline desert suitable for extensive salt making. River runoff into the Gulf has steadily diminished over the years due to the damming of rivers upstream. Changed flow regimes into the Gulf, and a negative water balance (i.e., more water evaporates than is recharged through rainfall and river runoff), is correlated with growing salinity of the inner Gulf waters.



Geomorphologically, the Gulf of Kachchh is characterized by sandy beaches in the north coast and inter-tidal mudflats in the south. Generally, vegetation such as mangroves favour the north while the southern Gulf is rich in coral reefs. Numerous shoals are found towards the mouth of the Gulf.

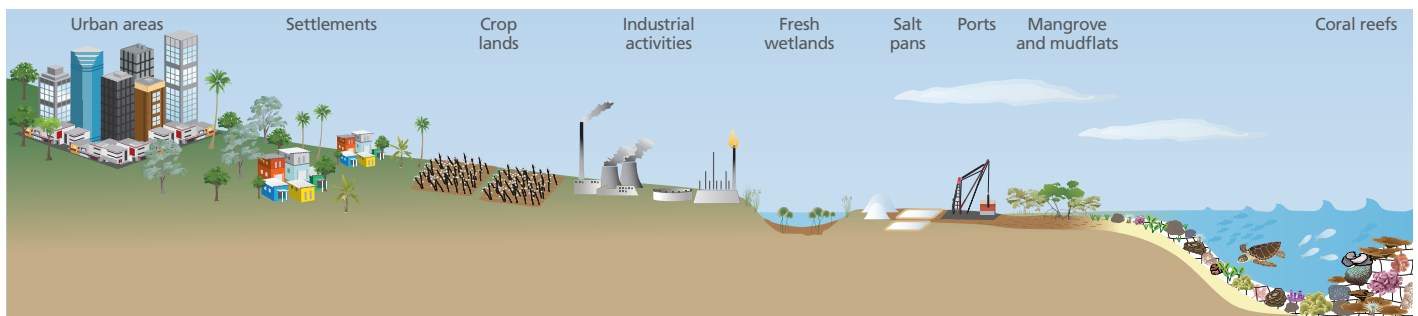


With high tidal range, negligible land run-off and irregular topography, the waters in the Gulf of Kachchh are vertically homogeneous in terms of salinity and temperature.

The Gulf of Kachchh is one of only four remaining locations along the Indian coast where live corals occur. Much of the remaining coral is located within a 16,289 ha Marine National Park and 45,592 ha Marine Sanctuary, both located along the southern coastline.

The land surfaces surrounding the Gulf of Kachchh host a transition from urban and rural settlements in the watershed, through to industry and maritime ports along the coastline. This mosaic of anthropogenic activities

is interspersed with freshwater wetlands, mangroves, tidal mudflats and bounded by extensive coral reef habitat mostly in the south. These natural ecosystems are not only affected by physical disturbances, but also by the wastes generated from oil and petrochemical refineries; chemical, fertiliser, cement and power production plants; port development; ship breaking; and sewage discharge. This cumulative mix of human-based activities and natural ecosystems create a significant challenge for environmental management in the region.



A general conceptual representation of the various human activities and natural ecosystems that exist on land and in water areas of the Gulf of Kachchh region.

Ecosystem goods and services

The Gulf of Kachchh has some of the most northern coral reefs in India. These ecosystems form the foundation of the marine food web which, in turn, supports a rich biodiversity of sea life. The coral reefs also provide commercial and non-commercial benefits such as income from tourism, fishing, new drugs and biochemicals, as well as coastal storm protection and recreation.

The State of Gujarat has the second largest mangrove cover in India. Mangroves provide storm protection that would otherwise erode the shoreline and flood communities. Mangroves safeguard agricultural lands from salinity ingress. Additionally, mangroves are one of the most productive ecosystems, providing nursery habitat for economically important fish and shellfish, as well as supporting birds, reptiles, and mammals.



The high biodiversity of coral reefs provides greater ecosystem stability and decreases vulnerability to external pressures.



A variety of crustaceans and molluscs find food and shelter on and at the base of mangroves.

STEP 1 RECOMMENDATIONS

Additional research and quantification are needed in several areas to develop a clearer foundation for the Cumulative Environmental Impact Assessment.

- Expand descriptions for key environmental features (e.g., temporal and spatial distribution of rainfall, river flow, residence time).
- Evaluate flow paths for catchment surface water to link potential pressures to Gulf waters.

Step 2: Major Pressures

2 Current pressures

Gujarat's coasts are facing a rush of rapid urban and industrial development. Approximately 70% of India's crude oil is imported through two major ports and several smaller facilities in the Gulf of Kachchh. The region also has two of the world's largest refineries, several expanding towns and industrial centres, as well as India's largest salt industry. It is primarily human activities such as these that challenge the viability of the Gulf marine ecosystem.

<p>1909: First marine zoological studies of Okha</p> <p>1919: Notification of Mangrove Forest</p> <p>1927: Indian Forest Act and Okha Port expanded</p>	<p>1950: Kandla Port operational</p> <p>1955: Navlakhi Port operational</p> <p>1956: Mangrove Forests Notification by Saurashtra Government</p>	<p>1970s: Large-scale mangrove deforestation for creation and leasing of salt pan areas</p> <p>1972: Wildlife (Protection) Act</p> <p>1974: Gujarat Pollution Control Board created</p>	<p>1980: Marine Sanctuary established</p> <p>1982: Marine National Park and Khijadiya Bird Sanctuary established; Addition to Marine Sanctuary</p>	<p>1984: Gujarat State Fertilizer & Chemicals Ltd jetty completed; Ship-breaking and recycling at Sachana begun; GSECL Thermal Power Plant at Sikka operational</p>
<p>pre-1950s EXTRACTION PERIOD</p>		<p>1950 1960 PROTECTION PERIOD</p>	<p>1970 PROTECTION PERIOD</p>	
<p>1930: Coral mining begun</p> <p>1933: Bedi Port operational</p> <p>1937: Tata Chemicals Ltd at Mithapur operational</p> <p>1940: Digvijay Cement Co at Sikka operational</p> <p>1949: Sikka Port established</p>	<p>1958: Auction of window-pane oyster fishery</p> <p>1960: Mandvi Port expanded</p> <p>1967: Gujarat State Fertilizers & Chemicals Ltd operational</p> <p>1969: Fisheries Research Station at Okha established</p>	<p>1974: Water (Prevention and Control of Pollution) Act</p> <p>1978: Indian Oil Corp Ltd subsea pipeline laid and Single Point Mooring operational</p> <p>Kandla Port Trust Offshore Oil Terminal at Vadinar operational</p>	<p>1982: GEER Foundation established</p> <p>1983: Coral mining banned in Marine National Park; Mangrove plantation begun in Marine National Park</p> <p>Cyclone</p>	<p>1986: The Environment (Protection) Act</p> <p>1988: Tata Chemicals Ltd at Mithapur subsea pipeline laid in Marine National Park</p>



URBAN SEWAGE AND WASTE

Some urban areas and industrial townships continue to release untreated sewage and municipal waste, potentially introducing pathogens and causing eutrophication in the Gulf.



Plastics, which often comprise most of urban waste, can entangle or are eaten by Gulf marine life, causing injury and even mortality.

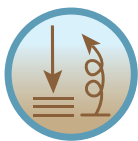


AGRICULTURAL RUNOFF

During monsoon, stormwater from farm fields picks up toxic pesticides and excess fertilisers, and deposits them, ultimately, into the Gulf, resulting in eutrophication and algal bloom events.



Certain pesticides have been shown to pose a risk to humans, especially to those working in and around farms, as well as undesirable side effects to the Gulf environment.



TURBIDITY

Mangrove deforestation and deep-sea dredging for ports and industrial sites deposit sediment and increase turbidity in the Gulf, which endanger coral and seagrass health.



Clearing mangroves and levelling mudflats erodes shorelines and resuspends sediment, causing turbidity in the Gulf, to the detriment of marine life.



SALT PAN DISCHARGE

Increased salinity in seawater and soil from salt pan discharge—threatening coral reefs and contaminating groundwater and agricultural lands—is a significant pressure in the Gulf.



An output of 2550 million litres of bitter, toxic to mangroves, is discharged annually from salt pans around the Gulf, increasing seawater and soil salinity.



INDUSTRIAL DEVELOPMENT

Oil spills and pipeline leaks, ship ballast water release, chemical plant effluent discharge, sea cargo vessel traffic, and warmed, high salinity power plant outfalls are all increasing risks to Gulf corals, seabirds, mangroves, and fisheries.



Coal-fired power plants, of which there are several around the Gulf and more planned, produce air pollution that is harmful to human health and contributes to global warming.

Development is not new to the Gulf of Kachchh, having been described from as early as 1930s with the onset of coral mining and chemical production. Termed the “**extraction period**”, the 1930s through the 1960s saw the region influenced by significant development activity in cement production, port development, mangrove deforestation, and salt pan areas. This was followed in the 1970s by the “**protection period**” during which the establishment of numerous government agencies and initiatives began to focus on the protection of the Gulf’s natural ecosystems via pollution management, sanctuary establishment, and increased regulation. From 2000 onwards, management of the region entered the “**restoration period**” where efforts are being focused on reversing the damage caused to the natural environment from almost 100 years of intense development. This is in itself a considerable task, as the region continues to experience rapid industrialization and large-scale coastal infrastructure development projects alongside restoration efforts.

<p>1991: Coastal Reg. Zone Notification; Sea turtle conservation programme begun</p> <p>1992: Fisheries Research Station at Sikka established; Gujarat Ecology Commission created</p>	<p>1995: Oil spill</p> <p>1996: Coral mortality event at Vadinar due to sedimentation</p> <p>1997: Reliance Oil Ltd refinery at Jamnagar begun operations</p>	<p>2001: 7.6 magnitude earthquake</p> <p>2002: Gulf of Kachchh granted special status for industrial development</p>	<p>2006: Ecological and socioeconomic study in Marine National Park and Sanctuary</p> <p>2007: Oil spill</p>	<p>2010: ICZM Project begun; Jamnagar sewage treatment plant included in ICZM Project</p> <p><i>Coral bleaching event</i></p>
<h2 style="color: #4682b4;">1990</h2>		<h2 style="color: #4682b4;">2000 and forward RESTORATION PERIOD</h2>		
<p>1993: GSECL Thermal Power Plant at Sikka begun operations</p> <p>1994: Marine Management Plan for Marine National Park; Mangrove Development Conserv. Project begun</p> <p>1995: Camel grazing banned in Marine National Park</p>	<p>1997: First Marine Ecological Study by GEER Foundation</p> <p>1998: Mundra Port expanded; Coral bleaching event; Oil spill; Cyclone</p> <p>1999: First biodiversity study in Marine National Park</p> <p><i>Oil spill</i></p>	<p>2004: Essar Oil Ltd refinery at Vadinar begun operations; <i>Oil spill</i></p> <p>2005: Sea turtle hatchery at Madhopur established; Pilot program for coral translocation begun</p>	<p>2009: Adani Power Thermal Power Plant at Mundra commissioned; Bharat Oman Refinery Ltd subsea pipeline laid in Marine National Park</p> <p>2010: Essar Thermal Power Station at Vadinar operational</p>	<p>2012: Tata Power Ultra Mega Power Plant at Mundra operational</p> <p>2013: Ship breaking and recycling activities ceased; Eco-sensitive Zone declared around Marine Park and Sanctuary</p>

Future pressures

The proximity to oil exporting countries in the Middle East is driving the rapid development of the Gulf of Kachchh as a crude oil import gateway to India. New and/or expanded port development and associated shipping infrastructure, oil refineries, power plants, and shipyards are planned along the coastline. Considering the quantity of oil handled and transported through the Gulf, there is an increasing risk of oil spills and pipeline leaks that would have devastating effects on the marine environment and attract worldwide media attention. This, combined with increasing energy and resource demands from a growing population that will in itself generate more waste, poses a significant management challenge that will be further exacerbated by the additional stresses of climate change (increasing temperatures, variable rainfall patterns, and rising sea levels). Hence, there is an urgent need

for a framework that assesses the cumulative environmental impact of development in the Gulf of Kachchh and provides robust input into managing the region in the future.



As demand for land dedicated to industry increases, important ecosystems may be damaged or destroyed in the process.

STEP 2 RECOMMENDATIONS

Expansion and quantification of the qualitative description of current and future pressures provided during the Workshop is necessary.

- Quantify current pressures using demographic data, effluent loading, and model information.
- Evaluate current monitoring programme to determine if sampling site locations adequately represent hotspots of activity and serve as sentinel locations for resource impact detection.
- Comprehensive evaluation of future pressures through GIS analysis of future development from comprehensive planning documents.
- Evaluate the conceptual linkages between these pressures, and the features and values identified in Step 1.

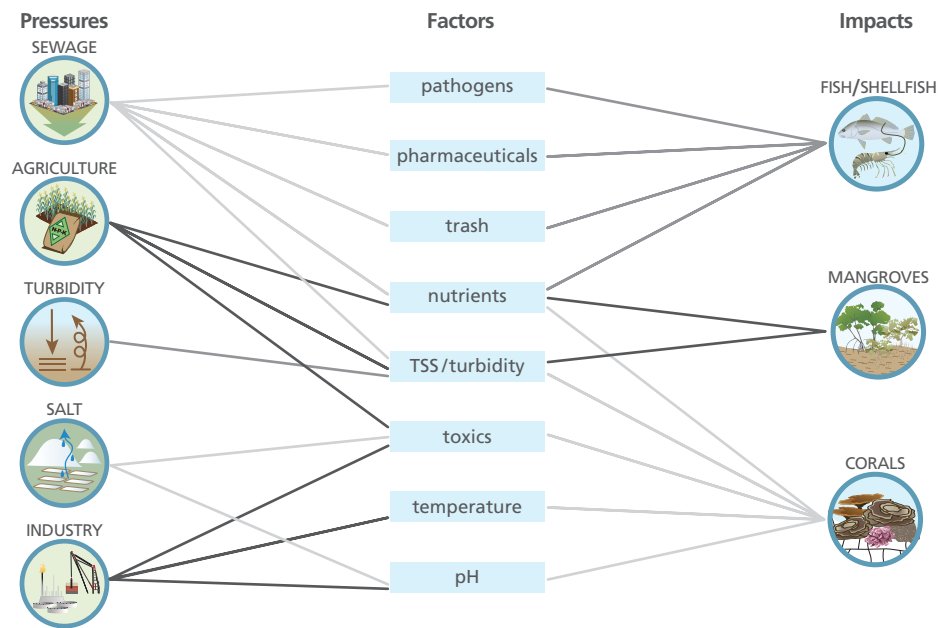
Step 3: State of the Environment

3

Status and trends

To prepare the foundation for the Cumulative Environmental Impact Assessment, a comprehensive state of the environment assessment will be required. The assessment should be conducted within the context of the ecosystem features identified in Step 1, and the effects that the pressures identified in Step 2 may have on those features. This conceptual

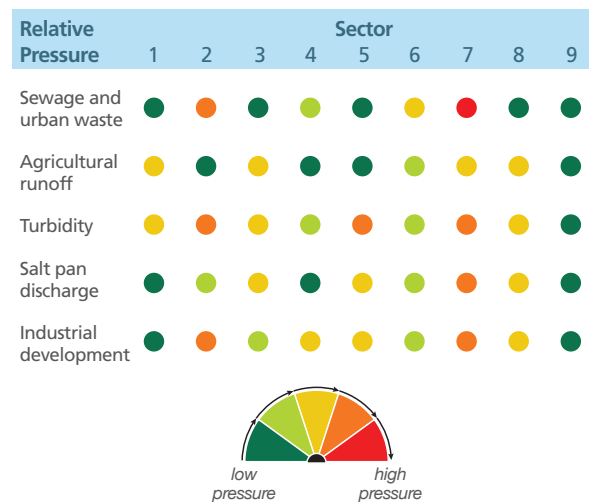
linkage sets the stage for the parameters that should be included in these monitoring efforts. A careful evaluation of the current monitoring programme vis à vis the locations of features and pressures in the Gulf of Kachchh, and the parameters currently collected, will suggest specific modifications to the monitoring programme that should be considered.



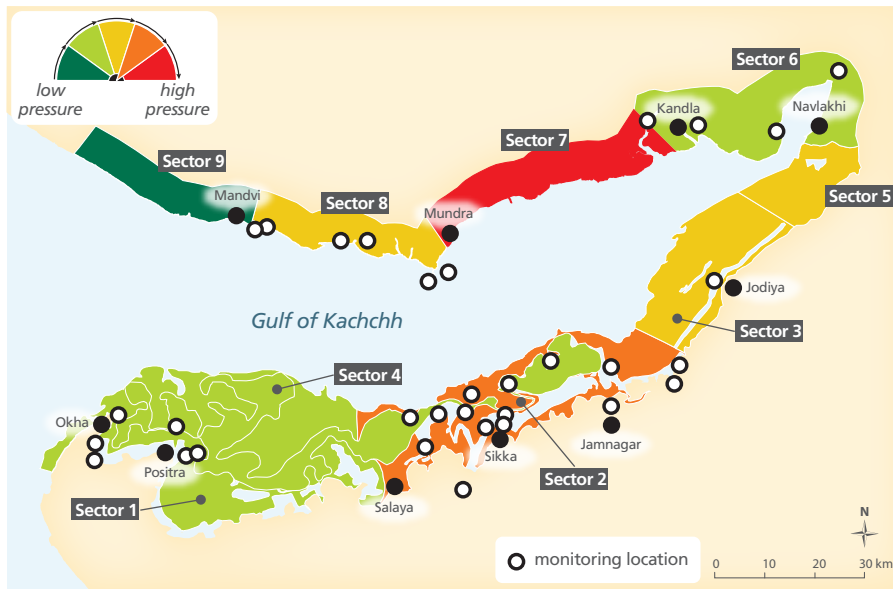
Identification of the conceptual linkages between pressures in the region and the potential impacts on important environmental features allows selection of important parameters for the monitoring programme.

Hotspots of vulnerability

A qualitative assessment of the location and intensity of pressures along the coastal margin of the Gulf of Kachchh was estimated by Workshop participants to assess likely hotspots of cumulative impact. Five pressures were identified for assessment in each of the nine identified Gulf sectors: i) sewage and urban waste; ii) agricultural runoff; iii) turbidity; iv) salt pan discharge; and, v) industrial development. Each pressure was estimated across five levels of relative intensity, ranging from low pressure (dark green) to high pressure (red), and these are presented in this table. The cumulative intensity of pressures for each of the nine sectors were averaged and are presented using the same colour scheme in the map shown at the top of the opposite page. This assessment should be repeated with quantitative data when the Cumulative Environmental Impact Assessment is implemented.



As estimated by Workshop participants, qualitative pressure assessment results by region and pressure category. Green indicates low pressure relative to red, which indicates high pressure.



Spatial results of qualitative pressure assessment, as estimated by Workshop participants. Overlaying current monitoring locations may suggest the need for additional hotspot and sentinel monitoring sites.

Nine Gulf sectors

- Sector 1** Western Marine National Park and Sanctuary (MNPS)
- Sector 2** Central MNPS
- Sector 3** Eastern MNPS
- Sector 4** Islands MNPS
- Sector 5** Southeastern Gulf of Kachchh (GoK)
- Sector 6** Northeastern GoK
- Sector 7** Eastern central GoK
- Sector 8** Western central GoK
- Sector 9** Northwestern GoK

SECTOR 1 – WESTERN MNPS

Sector 1 was characterised as having moderate pressure from agricultural runoff and turbidity.

SECTOR 2 – CENTRAL MNPS

Sector 2 was characterised as having moderate-high pressure from sewage and urban waste, turbidity, and industrial development, and low-moderate pressure from salt pan discharge.

SECTOR 3 – EASTERN MNPS

Sector 3 was characterised as having moderate pressure from agricultural runoff, turbidity, and salt pan discharge, and low-moderate pressure from industrial development.

SECTOR 4 – ISLANDS MNPS

Sector 4 was characterised as having moderate pressure from industrial development, and low pressure from sewage and urban waste and turbidity. Fishing has also been identified as an additional activity in this sector.

SECTOR 5 – SOUTHEASTERN GULF OF KACHCHH

Sector 5 was characterised as having high-moderate pressure from turbidity, and moderate pressure from salt pan discharge and industrial development.

SECTOR 6 – NORTHEASTERN GULF OF KACHCHH

Sector 6 was characterised as having moderate pressure from sewage and urban waste, and low-moderate pressure for agricultural runoff, turbidity, salt pan discharge, and industrial development.

SECTOR 7 – EASTERN CENTRAL GULF OF KACHCHH

Sector 7 was characterised as having high pressure from sewage and urban runoff, moderate pressure from agricultural runoff, and moderate-high pressure from turbidity, salt pan discharge, and industrial development.

SECTOR 8 – WESTERN CENTRAL GULF OF KACHCHH

Sector 8 was characterised as having moderate pressure from agricultural runoff, turbidity, salt pan discharge and industrial development.

SECTOR 9 – NORTHWESTERN GULF OF KACHCHH

Sector 9 was characterised as having low pressure from all activities.

STEP 3 RECOMMENDATIONS

Additional quantitative data is necessary to document baseline conditions and enable development of linkages between pressures and environmental impacts. Assessment and trend evaluations should be conducted for the following:

- Hotspot and sentinel locations at sampling sites located in Step 3;
- Water quality data from all available sources (e.g., State Project Management Unit, Gujarat, and Gujarat Pollution Control Board);
- Resource and value assessment data (e.g., mangrove and coral density and distribution); and,
- Expand monitoring to include sampling sites in the central area of the Gulf of Kachchh.

Step 4: Linking Pressures to Impacts

4

A methodology to reasonably foresee future development of the region is a critical component of the framework. This step addresses how the assessment framework will predict the likelihood and magnitude of future impacts from new and/or growing activities in the Gulf, and the inevitable uncertainty entailed in doing so. This will require an understanding of what the relative contribution of new and/or growing activities will have towards the existing situation in the Gulf; what indicators and thresholds will be used to measure and assess this; and what specific government and/or company goals and management objectives exist or are proposed to address the activities' cumulative effects. This step will require sound estimates of future trends in population growth, recreation, and industrial growth. The end of this phase should include a summary of the extent and location of activities that are likely to increase in the Gulf. This can be overlain with hotspot information to assist future environmental management and planning.

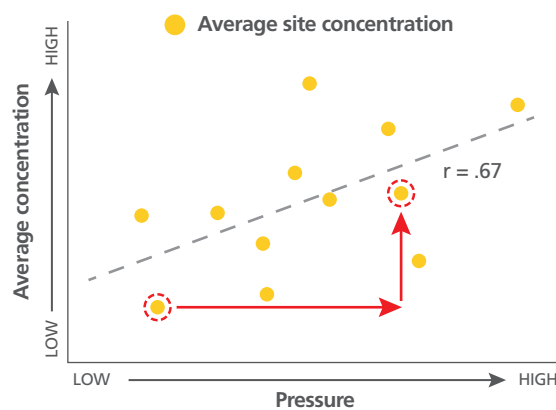
Linking the additive or interactive effects of current and future pressures to impacts on ecosystem features is the primary output of the Cumulative Environmental Impact Assessment. This primary output can then be used to influence development planning, conservation, and restoration, through the adaptive management cycle. This phase necessarily builds on the previous steps in the framework: valued features in the ecosystem that are to be protected or restored must be identified; current and future pressures on these resources must be identified and quantified; and, comprehensive monitoring data must be available to detect these linkages.

It is notoriously difficult to quantify the cumulative effects of pressures or pollutants on specific ecosystem endpoints with statistical precision. For example, if a sampling site is showing elevated total suspended sediments, is this a result of nearby agricultural runoff, or





is it because of re-suspended sediments from dredging activities at nearby port facilities? Most likely, it is a combination of effects and it is difficult to assign relative contributions of the different potential sources. High spatial and temporal resolution monitoring data and multiple analytical techniques are often employed to evaluate these effects. These techniques may include multiple linear or non-linear regression, regression trees, or multivariate analysis. Available monitoring data, including from added hotspot and sentinel analysis sites will be critical to quantify these connections. Other methods to demonstrate these connections and predict outcomes in mitigation or restoration efforts include physical, hydrodynamic, and GIS-based models. These methods will require extensive parameterisation and may not be possible in all instances.



A statistical model can use a relationship of pressure to impacts to project future impacts if pressures are increased.

STEP 4 RECOMMENDATIONS

Additional activities will be required to quantify the effects of pollution from specific sources on status and trends in water quality, resource, or ecosystem health.

- Develop recommendations based on model results to determine additional controls necessary for specific pollution sources.
- Correlation of changes in pollution from multiple sources with changes in water quality, habitat, or ecosystem health.
- Catchment and hydrodynamic model development.

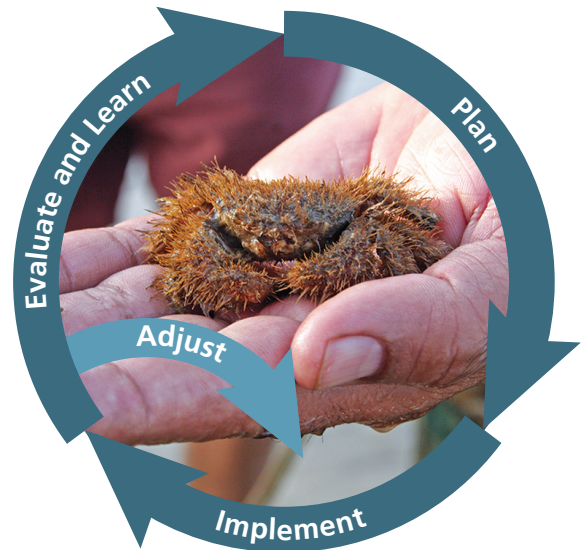
Step 5: Integrating Results into Action

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Information obtained from Steps 1 – 4 will be the basis for a management plan for the region. The management plan will require clear geographical and temporal boundaries, transparent rationale and assumptions, and consensus among stakeholders.

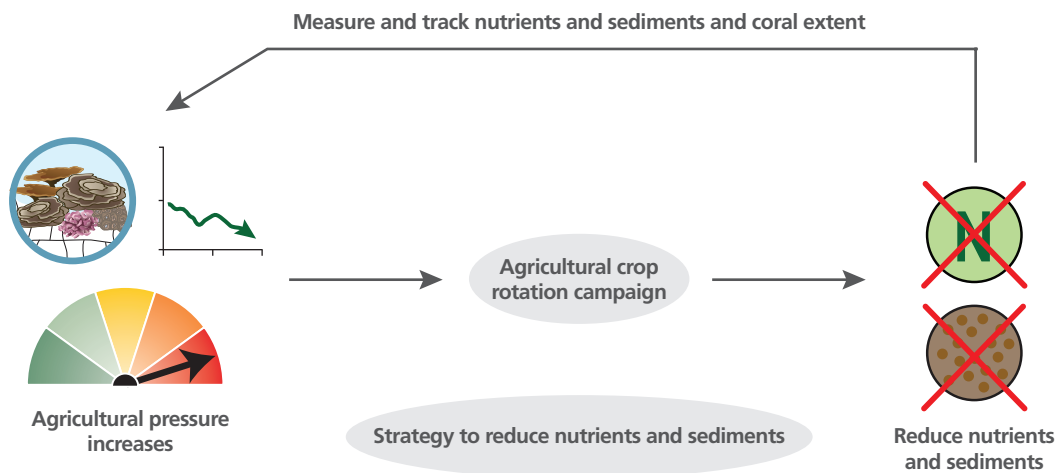
The Adaptive Management Phase is critical in response to the outcomes of cumulative impact assessments. What monitoring and research will be needed to detect adverse outcomes and reduce critical uncertainties? How will feedback from monitoring be incorporated into long-term management? What reporting mechanisms are anticipated? What alternate management options/measures would help improve the system?

Key components of the adaptive management process are consistent feedback and provision of strategies to reduce impacts to valued resources. Consistent feedback is provided by the comprehensive monitoring programme, which includes hotspot and sentinel monitoring. Strategies to protect resources are made possible through evaluation of pressures and their linkages to resources, including an ability to project stress reduction through effluent controls, mitigation, restoration, or conservation activities.



Adaptive management is a systematic process for continually improving management policies and practices by learning from the outcomes of operational programmes.

The monitoring programme will provide feedback about the effect that these management efforts have on the reduction of pressures, and the protection of resources. If desired effects to resources are not achieved, alternate or expanded strategies will be required.



An example of how adaptive management can be informed by the Cumulative Environmental Impact Assessment. In this hypothetical case, coral extent in a specific region is in decline or is projected to decline from planned agricultural intensification. A strategy to reduce nutrient and sediment runoff from crop areas is undertaken to reduce the threat. Continued water quality and resource monitoring will evaluate the effectiveness of the strategy.



Potential management recommendations

At the *Workshop on Cumulative Environmental Impact Assessment* in Gandhinagar, participants provided excellent ideas on the types of management activities that may be required to reduce pressures on Gulf natural resources. Some of these activities are described below.



SALT PANS

- Improve efficiencies of salt production to produce less bittern.
- Recover useful chemicals from bittern.



DREDGING

- Modernize dredging methods.
- Dispose of dredged material without plume generation, e.g., closed conveyance system.



AGRICULTURE

- Encourage seaweed harvesting and cultivation in high nutrient influx area without affecting the core ecosystem by local communities.
- Encourage organic farming methods to minimize fertiliser and pesticide use.



INDUSTRY AND PORTS

- Review industrial policies with regard to oil spill contingency plan.
- Require all ports to create Emergency Management Plans.
- Encourage zero discharge technology.



URBAN AREAS

- Improve wastewater treatment capacity and removal efficiency.
- Improve trash and solid waste collection.



FISHERIES

- Promote alternative livelihoods for local communities during monsoon season.
- Increase contiguous marine protected areas.
- Continue research on marine ecology and coral reefs.

STEP 5 RECOMMENDATIONS

Results from the cumulative impact assessment should be used to determine strategies to reduce or mitigate the impacts from pollution sources, and incorporated into a comprehensive management plan, including:

- Recommendations for limiting growth in sensitive areas;
- Recommendations for additional pollution controls if required (e.g., best management practices, specific pollutant reductions).
- Recommendations for mitigation activities to offset impacts from specific activities; and,

Completing the Cumulative Environmental Impact Assessment

This document has presented a 5-step framework for conducting the Cumulative Environmental Impact Assessment (CEIA) of the Gulf of Kachchh and has provided clear recommendations for achieving each step in the assessment. Additional challenges in accomplishing these tasks and completing the assessment are programmatic, including:

PROVIDE A CLEAR RATIONALE FOR THE ASSESSMENT:

“Why do we need to conduct the CEIA?” There are clear benefits to completing the Cumulative Environmental Impact Assessment (CEIA). This framework describes several of these benefits, including the ability to pro-actively provide input to the adaptive management process.

PROVIDE A CLEAR PATH TO COMPLETING THE CEIA:

“What needs to be done?” The CEIA can be achieved in the 5-step framework outlined in this document. Working through the step recommendations for each step will move the process forward in a deliberate fashion. Although the framework is designed to present a clear path to completion, the final form of the CEIA has not been discussed. This should be identified early in the process to provide guidance in the development of the CEIA.

IDENTIFY A CLEAR TIMELINE TO ACHIEVE AND UPDATE THE CEIA:

“When will the assessment be completed, and when should it be updated?” The CEIA

is an extensive process that may take a year or more to fully implement. A realistic timeline should be established to perform and update the assessment, taking into account research and analytical requirements.

IDENTIFY RESOURCES TO COMPLETE THE CEIA:

“Who is going to do this work and how will funding be provided?” Each step outlined in the step recommendations will require substantial analytical and research effort to complete. The National Centre for Sustainable Coastal Management (NCSCM) will have the primary responsibility to identify the appropriate resources required to carry out the work of the assessment. To achieve objective and sustainable results from the CEIA, it is important that the CEIA be conducted by an objective and independent organisation—the NCSCM can fulfil this role well. Additional partner organisations will also be required to complete this work. The Workshop to begin the framework for the CEIA included several potential partners which may be expanded as the CEIA is conducted.

The economic vitality of the Gulf of Kachchh is symbolic of continued economic growth and prosperity in India. Preservation of the important natural resources and features of the Gulf will demonstrate that this continued development can be environmentally sustainable. Clear and comprehensive understanding of the cumulative environmental impacts from the many pressures affecting the Gulf is critical to achieving this goal.

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Assessment Gujarat Mangroves Coral Reef Gulf Of Kachchh Development

Navlakhi Pollution Marine Sanctuary Okha Ports Mud Flat Sikka Bittern Jamnagar Nursery Extraction Habitat Salt Pan Birds Agriculture Industry Society Sustainability Refinery Dredging Global Warming Hotspot Food Web

Mandvi Tourism Livelihood Adaptive Management Fish Environment Carbon Sink Mundra Restoration Storm Protection Runoff Benefits Pressures Crabs Bedi Sewage

Kandla Fishery Cyclones Flooding Marine Park Monitoring & Protection

