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Report No: ICR00004745

IMPLEMENTATION COMPLETION AND RESULTS REPORT

CR. 47720 and CR. 54130

ON A

CREDIT

IN THE AMOUNT OF SDR 164.10 MILLION

(US\$255.00 MILLION EQUIVALENT)

AND

AN ADDITIONAL FINANCING CREDIT

IN THE AMOUNT OF SDR 67.30 MILLION

(US\$104.00 MILLION EQUIVALENT)

TO THE

REPUBLIC OF INDIA

FOR AN

INDIA NATIONAL CYCLONE RISK MITIGATION PROJECT (1)

August 22, 2019

Urban, Resilience and Land Global Practice
South Asia Region

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CURRENCY EQUIVALENTS
(Exchange Rate Effective July 16, 2019)

Currency Unit = Indian Rupee (INR)

INR 71.88 = US\$1

US\$1.37 = SDR 1

Republic of India
GOVERNMENT FISCAL YEAR

April 1 – March 31

ABBREVIATIONS AND ACRONYMS

AF	Additional Financing
ADB	Asian Development Bank
AP	Andhra Pradesh
APSDMA	Andhra Pradesh State Disaster Management Authority
BCR	Benefit-cost Ratio
BME	Benefit Monitoring and Evaluation
BSNL	Bharat Sanchar Nigam Limited
CBA	Cost-Benefit Analysis
CPF	Country Partnership Framework
CPS	Country Partnership Strategy
CRED	Centre for Research on the Epidemiology of Disasters
CRZ	Coastal Regulation Zone
DDMA	District Disaster Management Authority
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
E&S	Environmental and Social
EFA	Economic and Financial Analysis
EOC	Emergency Operation Center
EMP	Environmental Management Plan
ERR	Economic Rate of Return
ESMF	Environmental and Social Management Framework
EWDS	Early Warning Dissemination System
FA	Financing Agreement
FM	Financial Management
FGD	Focus Group Discussion
GFDRR	Global Facility for Disaster Reduction and Recovery
GIS	Geographic Information System
GoAP	Government of Andhra Pradesh
GoI	Government of India
GoO	Government of Odisha
GRM	Grievance Redress Mechanism

GSM	Global System for Mobile
ICR	Implementation Completion and Results
IMD	India Meteorological Department
IRC	Indian Roads Congress
ISR	Implementation Status and Results
IUFR	Interim Unaudited Financial Report
JRDNA	Joint Rapid Damage and Needs Assessment
LBAS	Location-based Alerting System
M&E	Monitoring and Evaluation
MIS	Management Information System
MPCS	Multipurpose Cyclone Shelter
MTR	Midterm Review
NCRMP	National Cyclone Risk Mitigation Project
NDMA	National Disaster Management Authority
NIC	National Informatics Center
NIDM	National Institute of Disaster Management
NPV	Net Present Value
O&M	Operation and Maintenance
OSDMA	Odisha State Disaster Management Authority
PAD	Project Appraisal Document
PDNA	Post-Disaster Needs Assessment
PDO	Project Development Objective
PIU	Project Implementation Unit
PMU	Project Management Unit
PPR	Post Procurement Review
PSC	Project Steering Committee
PWD	Persons with disability
RAP	Resettlement Action Plan
R-PACS	Remote Public Alerting and Communication System
S&R	Search and Rescue
SBMDVT	Satellite-based Mobile Data Voice Terminal
SC	Scheduled Caste
SDMA	State Disaster Management Authority
SHG	Self-help Group
SMS	Short Message Service
ST	Scheduled Tribe
SWOT	Strength, Weakness, Opportunity, Threat
ToC	Theory of Change
ToT	Training of Trainer
TPQA	Third-Party Quality Auditor
UN	United Nations
ULB	Urban Local Bodies
UT	Union Territories
VSL	Value of a Statistical Life

Regional Vice President: Hartwig Schafer

Country Director: Junaid Kamal Ahmad

Global Practice Director: Sameh Naguib Wahba Tadros

Practice Manager: Christoph Pusch

Task Team Leader(s): Deepak Singh

ICR Main Contributor: Naho Shibuya and Peeyush Ramawtar Sekhsaria

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DATA SHEET

BASIC INFORMATION

Product Information

Project ID	Project Name
P092217	India National Cyclone Risk Mitigation Project (1)
Country	Financing Instrument
India	Investment Project Financing
Original EA Category	Revised EA Category
Full Assessment (A)	Full Assessment (A)

Organizations

Borrower	Implementing Agency
Republic of India	Odisha State Disaster Management Agency (OSDMA), Revenue (Disaster Management) Department - Andhra Pradesh, NDMA

Project Development Objective (PDO)

Original PDO

The Project Development Objection (PDO) of the National Cyclone Risk Mitigation Project (1) (NCRMP-1) is to reduce the vulnerability of coastal communities in Andhra Pradesh and Orissa to cyclone and other hydro meteorological hazards.

PDO as stated in the legal agreement

To reduce the vulnerability of coastal communities to cyclone and other hydro meteorological hazards.

**FINANCING**

	Original Amount (US\$)	Revised Amount (US\$)	Actual Disbursed (US\$)
World Bank Financing			
IDA-47720	255,000,000	238,685,981	221,520,335
IDA-54130	104,000,000	73,866,050	63,362,000
Total	359,000,000	312,552,031	284,882,335
Non-World Bank Financing			
Borrower/Recipient	64,000,000	96,000,000	85,230,000
Total	64,000,000	96,000,000	85,230,000
Total Project Cost	423,000,000	408,552,032	370,112,335

KEY DATES

Approval	Effectiveness	MTR Review	Original Closing	Actual Closing
22-Jun-2010	30-Mar-2011	03-May-2013	30-Apr-2015	31-Dec-2018

RESTRUCTURING AND/OR ADDITIONAL FINANCING

Date(s)	Amount Disbursed (US\$M)	Key Revisions
08-Apr-2014	71.44	Additional Financing Change in Results Framework
21-May-2015	108.11	Change in Loan Closing Date(s)
19-Oct-2015	118.19	Change in Loan Closing Date(s)
03-Oct-2017	220.09	Change in Loan Closing Date(s)

KEY RATINGS

Outcome	Bank Performance	M&E Quality
Moderately Satisfactory	Moderately Satisfactory	Substantial

**RATINGS OF PROJECT PERFORMANCE IN ISRs**

No.	Date ISR Archived	DO Rating	IP Rating	Actual Disbursements (US\$M)
01	03-Jan-2011	Satisfactory	Satisfactory	.28
02	10-Jul-2011	Satisfactory	Satisfactory	.31
03	05-Apr-2012	Satisfactory	Moderately Satisfactory	.31
04	04-Mar-2013	Moderately Satisfactory	Moderately Unsatisfactory	30.64
05	04-Dec-2013	Moderately Satisfactory	Moderately Satisfactory	51.44
06	28-Jun-2014	Moderately Satisfactory	Moderately Satisfactory	71.44
07	08-Oct-2014	Moderately Satisfactory	Moderately Satisfactory	108.11
08	24-Jun-2015	Moderately Satisfactory	Moderately Satisfactory	108.11
09	28-Dec-2015	Moderately Satisfactory	Moderately Satisfactory	119.24
10	22-Apr-2016	Moderately Satisfactory	Moderately Satisfactory	154.36
11	15-Dec-2016	Moderately Satisfactory	Moderately Satisfactory	173.86
12	12-Jun-2017	Moderately Satisfactory	Moderately Satisfactory	200.08
13	21-Jun-2018	Moderately Satisfactory	Moderately Satisfactory	245.13
14	07-Jan-2019	Moderately Satisfactory	Moderately Satisfactory	246.46

SECTORS AND THEMES**Sectors**

Major Sector/Sector (%)

Information and Communications Technologies **5**

ICT Infrastructure 5

Transportation **16**

Rural and Inter-Urban Roads 16



Water, Sanitation and Waste Management	79	
Public Administration - Water, Sanitation and Waste Management	13	
Other Water Supply, Sanitation and Waste Management	66	
Themes		
Major Theme/ Theme (Level 2)/ Theme (Level 3)	(%)	
Private Sector Development	100	
Jobs	100	
Finance	25	
Finance for Development	25	
Disaster Risk Finance	25	
Urban and Rural Development	75	
Disaster Risk Management	75	
Disaster Response and Recovery	25	
Disaster Risk Reduction	25	
Disaster Preparedness	25	
ADM STAFF		
Role	At Approval	At ICR
Regional Vice President:	Isabel M. Guerrero	Hartwig Schafer
Country Director:	N. Roberto Zagha	Junaid Kamal Ahmad
Director:	John Henry Stein	John A. Roome
Practice Manager:	William D. Kingdom	Christoph Pusch
Task Team Leader(s):	Christoph Pusch, Raghava Neti	Deepak Singh
ICR Contributing Author:		Naho Shibuya



I. PROJECT CONTEXT AND DEVELOPMENT OBJECTIVES

A. CONTEXT AT APPRAISAL

Context

1. **At the time of appraisal of the National Cyclone Risk Mitigation Project I (NCRMP-I) (the project), India was ranked as the second most disaster-hit country in the world.**¹ With an estimated annual economic loss from natural disasters at US\$9.8 billion,² the country is highly vulnerable to the impact of climate change and extreme events. In India, a high-impact climate change scenario with slow and non-inclusive development could bring 50 million people into poverty.³ Tropical cyclones have devastating impact on India's coastal regions. In the past 100 years, India experienced about 1,019 cyclones, of which 87 percent struck the eastern coast.⁴ The project therefore focused on the two eastern coastal states, Andhra Pradesh (AP) and Odisha. AP has a coastline of 974 km with nine coastal districts and about 73 percent of the state population living in rural areas. Odisha has a coastline of 476 km with six coastal districts and about 89 percent living in rural areas. Approximately 1 million residents in AP and 4 million in Odisha are at risk of cyclone with a 50-year return period while 2.3 million in AP and 5.6 million in Odisha are at risk of a 100-year cyclone.⁵

2. **Before project implementation, the Government of AP (GoAP) and the Government of Odisha (GoO) used conventional communication means to disseminate warnings to the coastal communities.** At the time of appraisal, AP and Odisha did not have any comprehensive early warning system in place; many vulnerable coastal villagers could not be alerted and therefore could not evacuate to safe shelters before the landfall of cyclones. The historical cyclones resulted in a catastrophic loss of lives, assets, and livelihoods, including the 1977 cyclone with a fatality of 10,000 people in AP, the 1990 Super Cyclone with a fatality of 967 people in AP, the 1996 Very Severe Cyclonic Storm with a fatality of 1,057 people in AP, and the 1999 Super Cyclone with a fatality of about 8,900 people in Odisha.⁶

3. **The project supported India's major policy shift from reactive post-disaster response to a proactive disaster risk reduction (DRR) approach.** Based on lessons learned from the large-scale natural disasters such as the 2001 Gujarat earthquake and the 2004 Indian Ocean Tsunami, the Government of India (GoI) enacted the Disaster Management Act in 2005. The Act mandated the establishment of the National Disaster Management Authority (NDMA), State Disaster Management Authorities (SDMAs), and District Disaster Management Authorities (DDMAs). The Andhra Pradesh State Disaster Management Authority (APSDMA) was established in 2007 and the Odisha State Disaster Management Authority

¹ Centre for Research on the Epidemiology of Disasters. 2011. *Annual Disaster Statistical Review 2010: The Numbers and Trends*.

² UNISDR. 2015. *Global Assessment Report on DRR*.

³ Hallegatte, S. et al. 2016. *Shock Waves: Managing the Impacts of Climate Change on Poverty*. World Bank.

⁴ World Bank. 2010. *NCRMP: Project Appraisal Document*. Report No: 52304-IN.

⁵ According to the Composite Risk Atlas developed by the project.

⁶ World Bank 2010.

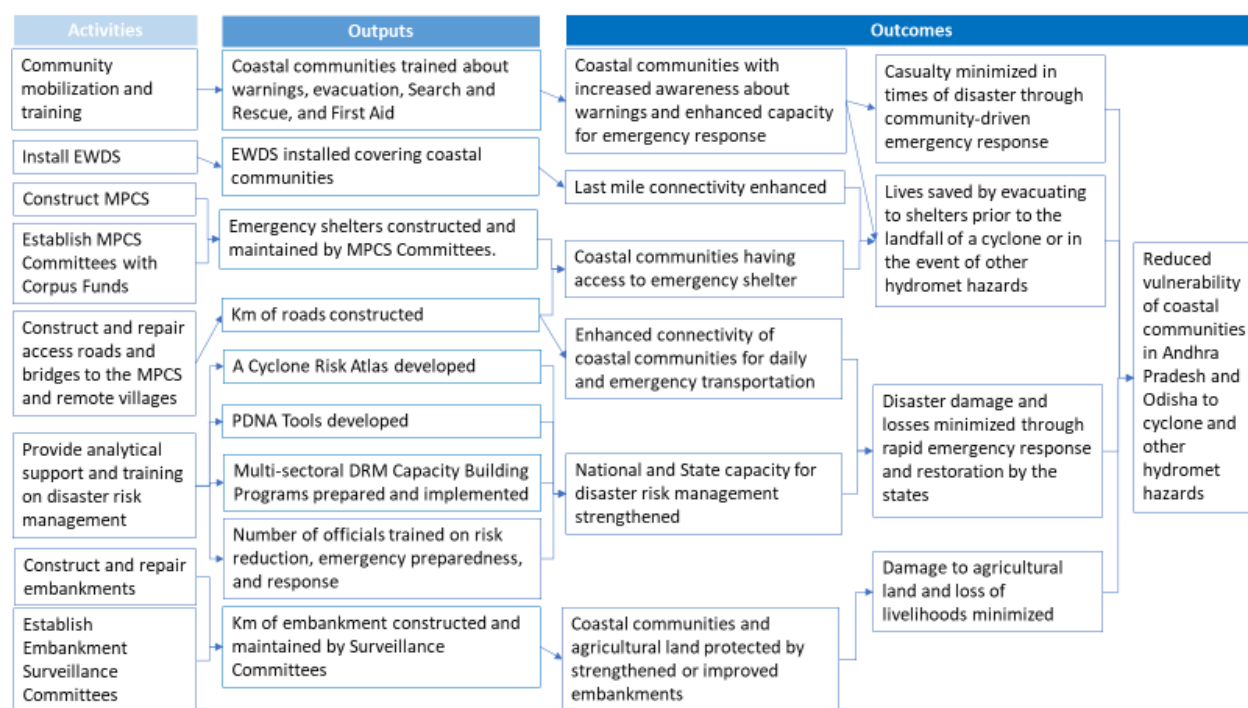
(OSDMA) in 2008.⁷ The project provided timely support to strengthen the national and state disaster risk management (DRM) agencies in their infancy.

4. **The project was strongly linked to the World Bank Group’s Country Partnership Strategy (CPS) for India for FY09–12.**⁸ To ensure development is sustainable (Pillar II), the CPS aimed to help increase the resilience of people and the economy to nature-related and man-made shocks. This was in line with the priorities identified in the National Action Plan on Climate Change and in support of India's comprehensive efforts to reduce the country’s vulnerability to cyclones and other natural hazards. The project was part of the Bank’s strategy to assist the GoI in integrating DRM into the long-term national development process in accordance with the country’s 12th Five-Year Plan (2007–2012).

Theory of Change (Results Chain)

5. The project’s Theory of Change (ToC), as described in the Project Appraisal Document (PAD), is illustrated in figure 1. The ToC was not required to be prepared at the time of project appraisal.

Figure 1. Theory of Change



Assumption: Accurate hydrometeorological forecasts are provided by the India Meteorological Department (IMD).

Note: DRM = disaster risk management; EWDS = Early Warning Dissemination System; MPCS = Multi-Purpose Cyclone Shelter; PDNA = Post-disaster Needs Assessment

⁷ The Orissa State Disaster Mitigation Authority was originally established in 1999 and changed to the OSDMA in 2008.

⁸ Report No. 46509-IN



Project Development Objectives (PDOs)

6. The PDO was to reduce vulnerability of coastal communities to cyclone and other hydrometeorological hazards.⁹

Key Expected Outcomes and Outcome Indicators

7. **The key expected outcomes at appraisal** were (i) targeted coastal communities covered by the Early Warning Dissemination System (EWDS), (ii) coastal communities having access to emergency shelters, (iii) agricultural land protected by strengthened embankments, and (iv) increased awareness about warnings and emergency response.

Components

8. The project consisted of the following four components. In addition, there was an unallocated contingency budget of US\$27.3 million.

9. **Component A: EWDS and Capacity Building for Coastal Communities** (Estimated Cost: US\$15 million; Actual Cost: US\$16.45 million). This component was designed to reduce the vulnerability of coastal communities by addressing the existing gap in dissemination of warning to the communities. This component had two subcomponents as follows: (i) improving the warning systems for coastal communities in AP and Odisha through the installation and operation of an EWDS, and through strengthening the operational capabilities of the state and district level emergency operation centers (EOCs); and (ii) strengthening the capacity of coastal communities of AP and Odisha to maintain and operate the EWDS and to carry out emergency mobilization.

10. **Component B: Cyclone Risk Mitigation Infrastructure** (Estimated Cost: US\$378 million including counterpart funding of US\$96 million; Actual Cost: US\$331 million including counterpart expenditure of US\$85.23). This component was designed to construct and improve the access to emergency shelter, evacuation, and protection against cyclone and other hydrometeorological hazards in high-risk areas. The investment portfolio included construction of multipurpose cyclone shelters (MPCSs), roads and bridges suitable for evacuation, and rehabilitation and upgrading of existing saline embankments.

11. **Component C: Technical Assistance for National and State-level Capacity Building and Knowledge Creation** (Estimated Cost: US\$6 million; Actual Cost: US\$3 million). This component was designed to (i) assist 13 vulnerable coastal states and union territories (UT) to improve their understanding of natural disaster risks and vulnerabilities better, (ii) strengthen their institutional capacity to address such risks and vulnerabilities, and (iii) support pilot activities implemented by NDMA, the National Institute of Disaster Management (NIDM), AP, and Odisha.

12. **Component D: Project Management and Implementation Support** (Estimated Cost: US\$28.7 million; Actual Cost: US\$18.27 million). This component was designed to provide support for project management and implementation by financing operating costs for the Project Management Unit (PMU),

⁹ The other hydrometeorological hazards include wind storms, flooding, and storm surges. The PDO stated in the PAD mentions the name of two states. The agreement mentions the two states in the component descriptions.



Project Implementation Units (PIUs), line departments and NIDM, office equipment, training and exposure visits, and consulting services for specialist activities.

B. SIGNIFICANT CHANGES DURING IMPLEMENTATION

Additional Financing

13. An additional financing (AF) of SDR67.3 million (US\$104 million equivalent) was provided to scale up the project’s development effectiveness as a lesson learned from Extremely Severe Cyclonic Storm Phailin of October 2013. In response to Cyclone Phailin, the GoI requested an AF and the Bank’s support for a joint rapid damage and needs assessment (JRDNA) in December 2013. The AF was approved by the Board on April 8, 2014. While the component structure and type of activities remained unchanged, the AF enabled the additional construction of 246 MPCs and 260 km of roads and bridges under Component B based on the JRDNA findings. The associated project management and implementation support under Component D was also scaled up. While the project had disbursed about 28 percent of the original financing at the time of AF, 90 percent was already committed. Therefore, the AF was provided in accordance with OP 10.00 for scaling up the development effectiveness as the original financing was insufficient for the additional activities. An additional counterpart funding of SDR15.5 million (US\$32 million equivalent) was also included in the expanded project.

Revised PDO Indicators and Results Framework

14. While the PDO remained the same, the PDO indicators were updated at the time of AF as summarized in table 1.

Table 1. Original and Revised PDO Indicators

Original PDO Indicators	Revised PDO Indicators
Proportion of people having access to emergency shelters in Odisha Baseline: To be established but assumed 30% Target: 60%	Proportion of people having access to emergency shelters in Odisha Baseline: 30% Target: 80%
Proportion of people having access to emergency shelters in Andhra Pradesh Baseline: To be established but assumed 84% Target: 98%	Proportion of people having access to emergency shelters in Andhra Pradesh Baseline: 78% Target: 88%
Number of people and hectares of land protected by strengthened/improved embankments Baseline: To be established Target: To be established based on baseline	Land protected by strengthened/improved embankments Baseline: Zero Target: 30,000 ha
Increased awareness about warnings and emergency response Baseline: Not applicable Target: Not applicable	Increased awareness about warnings and emergency response ^a Baseline: 30% Target: 100%

Note: a. The baseline and target were assigned based on the Benefit Monitoring Evaluation study conducted by the NDMA, although these were not established in the official Results Framework.



15. **The AF revised the Results Framework based on the scaled-up activities and findings of the feasibility studies on embankments, but did not affect the original ToC.** It increased the intermediate results indicators on the MPCs by 86 percent and on access roads by 25 percent. The additional activities did not result in a change in the safeguard category. The AF reduced the intermediate results indicator on the length of embankments by 50 percent, considering the improved designs, environmental sensitivity, and revised costing. While scaling up the length of embankment was considered at the time of AF, the Gol did not request for this considering the cost implication. The target on proportion of people having access to emergency shelters in AP was reduced by 10 percent, considering the updated baseline that was lower than the original estimate and the revised design capacity of MPCs, considering the land availability.

Level-2 Restructurings

16. **Three Level-2 restructurings extended the project's closing date because of the natural disasters, political environment, and implementation challenges.** The first restructuring was approved on May 21, 2015 and extended the closing date of original financing by 6 months (October 31, 2015)¹⁰ as part of the country's portfolio-wide restructuring of 107 projects to extend the timeline for submission of annual audit reports. This was a retroactive re-opening and extension, three weeks after the credit had closed. The second restructuring was approved on October 19, 2015 to extend the closing date of the original financing by 23 months (to October 2, 2017)¹¹ due to: (i) the delay in obtaining environmental clearances; (ii) challenges in identifying appropriate land for some works; (iii) the need to re-tender some works due to a lack of bids; (iv) state bifurcation process in AP; and (v) disruptions caused by Cyclone Phailin and Very Severe Cyclonic Storm Hudhud of 2014 that hit the coastal districts of AP with an estimated damage of US\$2.16 billion.¹² The third restructuring was approved on October 3, 2017 to extend the closing date of both the original financing and AF to December 31, 2018 due to implementation challenges mainly faced in AP and Component A, as discussed in section III.B.¹³ Extensions of the closing date helped the PMU and PIUs make significant progress toward the achievement of the PDO.

II. OUTCOME

A. RELEVANCE OF PDO

Assessment of Relevance of PDO and Rating

Rating: High

17. **The PDO remains highly aligned with the World Bank Group's Country Partnership Framework (CPF) for India for FY18–22.**¹⁴ The CPF recognizes that India faces the challenge of sustaining rapid economic growth while reducing the vulnerability of its large population and growing stock of infrastructure. The CPF highlights that improving DRM and resilience to climate change (Objective 1.5) is critical for “promoting resource-efficient growth and poverty reduction” which is one of the three focus

¹⁰ World Bank. 2015. Restructuring Paper on a Proposed Restructuring of the Republic of India Portfolio Projects. Report No: 89340-IN.

¹¹ World Bank. 2015. Restructuring Paper on a Proposed Restructuring of NCRMP (I) CR. 4772 to India. Report No: RES20479.

¹² GoAP, World Bank, and ADB. 2014. *Joint Rapid Damage and Needs Assessment: Cyclone Hudhud*.

¹³ World Bank. 2017. Restructuring Paper on a Proposed Restructuring of NCRMP (I) to India. Report No: RES27861.

¹⁴ Report No. 126667-IN



areas of the World Bank engagement with India. The PDO remained important to achieving the CPF objective by reducing the vulnerability of two states to cyclone and other hydrometeorological hazards.

18. **The PDO is highly relevant to Gol's and global agenda for promoting DRR.** One of the CPF's priority areas is to support India in its global leadership role in DRR. The Gol is strongly committed to address DRR as evident in the National Disaster Management Plan (NDMP) of 2016. The NDMP is consistent with the Sendai Framework for Disaster Risk Reduction 2015-2030 endorsed by the United Nations (UN) General Assembly and adopted by the Gol. The Plan acknowledges the project as one of the important schemes for financing disaster risk mitigation. The project was the first World Bank-funded program in India that exclusively focused on ex ante disaster risk mitigation and remained relevant to the country's and global development objectives.

19. **The PDO is aligned with the CPF's approach to engaging a federal India for targeting catalytic contributions, including strategic partnerships with select states.** The CPF focuses on identifying entry points and change layers at various levels of the country's federal system. The PDO is aligned with this approach by focusing on reducing the vulnerability of coastal communities across two states. This is also consistent with NDMA's vision to "make India disaster resilient, achieve substantial disaster risk reduction, and significantly decrease the losses of life, livelihoods, and assets – economic, physical, social, cultural, and environmental – by maximizing the ability to cope with disasters at all levels of administration as well as among communities."¹⁵ The project pioneered and laid the foundation for the subsequent DRM engagement in the country by successfully developing an effective entry point at the national, state, and district levels, namely the NDMA, NIDM, SDMAs, and DDMA's.

B. ACHIEVEMENT OF PDOs (EFFICACY)

Assessment of Achievement of Each Objective/Outcome

Outcome 1. Targeted coastal population covered by the Early Warning Dissemination System

Baseline: 0 percent; Target: 100 percent; Actual: 100 percent

20. **The project built the country's first-of-its-kind comprehensive EWDS providing last-mile connectivity to 1,055 coastal villages in AP and Odisha and covering approximately 4.2 million people through alert sirens.**¹⁶ Warnings were previously disseminated through the use of print and electronic media and by local administrations and government officials visiting the villages with handheld loudspeakers that had a limited coverage. Based on advice from a knowledge partner and third-party quality auditor (TPQA), the project installed 275 alert sirens with an area of influence of 1.5 km to 2 km radius each, covering all of the 1,740 vulnerable coastal villages. The sirens were installed at the MPCs, district and block EOCs, and fish landing centers. The project built 413 towers and poles for mounting alert sirens, which were designed to withstand the wind speed of up to 250 kmph. A beneficiary survey¹⁷ conducted in December 2017 confirmed that all the 2,000 households interviewed in AP and Odisha had received warning through alert sirens before a cyclone hit the coastal areas. Although the project did not

¹⁵ NDMA. 2016. *NDMP*.

¹⁶ GoAP. 2019. ICR for NCRMP-I; OSDMA. 2019a. Information related to ICR of NCRMP-I (Letter No. 2668/OSDMA).

¹⁷ NDMA. 2018. *Benefit Monitoring Evaluation Report on National Cyclone Risk Mitigation Project*.



meet the intermediate results indicator of 3,400 alert systems, it still met the outcome indicator because the project adopted sirens with a greater coverage of distance as the technology advanced during implementation. The project also trained nearly 420 government officials and village representatives in operating and maintaining the EWDS. The current operation and maintenance (O&M) contract of EWDS equipment is up to 2023 including a warranty period of two years, and the SDMA's are responsible for budgeting and implementing O&M thereafter.

21. **In addition to alert sirens, the project installed a location-based alerting system (LBAS) using Global System for Mobile (GSM) communications in Odisha, covering approximately 3.75 million people.** The Odisha PIU integrated the LBAS with Bharat Sanchar Nigam Limited (BSNL), India's state-owned telecommunications company. As of March 2019, approximately 5.75 million BSNL subscribers in Odisha can receive warnings through short message service (SMS), including nearly 928,700 coastal residents.¹⁸ The LBAS is built with a feedback mechanism, which provides information on how many messages are under process, delivered, or failed once a polygon with alert message is sent from the state EOC to BSNL. The LBAS is compatible with a Common Alerting Protocol¹⁹ that the GoI is considering installing nationwide in the future. At the time of project closing, the AP PIU was still in the process of integrating the project's multi-hazard LBAS with telecommunication service providers. Because of the delay, the APSDMA has with its own funds installed an LBAS for lightning without the feedback mechanism. OSDMA plans to integrate the LBAS with two additional telecommunication service providers.

22. **During Cyclones Phailin of 2013 and Hudhud of 2014 when the project's EWDS was not yet installed, the GoAP and GoO used conventional communication means for warning, consuming a considerable amount of time and human resources in times of emergency.** The states used TV, radio, print media, and handheld loudspeakers to provide warnings to the coastal communities 36 hours before the landfalls, and built on earlier mock drills and awareness raising activities. This approach led to the evacuation of approximately 1 million people in Odisha with 50 fatalities as well as the evacuation of 250,000 people in AP with 61 fatalities, far below the thousands of fatalities in previous cyclones of similar intensity. However, it took a considerable amount of the SDMA's and local administration's time and human resources away from other critical emergency preparedness and coordination activities.

23. **The alert sirens and LBAS contributed to more efficient and timely evacuation of 1.55 million coastal residents during the Extremely Severe Cyclonic Storm Fani that hit Odisha on May 3, 2019.** The completion of EWDS in late 2018 enabled the OSDMA to efficiently provide early warnings to the coastal communities by remotely operating alert sirens 36 to 48 hours before the landfall²⁰ and send 18 million SMS to BSNL subscribers through LBAS. The OSDMA disseminated warnings in the local language about heavy rainfall, wind, wave height, and storm surge from the state EOC based on the IMD's accurate forecast of Cyclone Fani's track, landfall, and intensity. This led to one of the largest emergency evacuations in a record timeframe, reducing the number of fatalities to 64 people.²¹ With effective warning, fishing activities were suspended before the landfall and 200,000 fishermen were evacuated from the vulnerable coastal areas, resulting in zero casualty of fishermen. Approximately 25,000 tourists

¹⁸ OSDMA 2019a.

¹⁹ A digital format for exchanging emergency alerts that allows a consistent alert message to be disseminated simultaneously over different communications means including sirens, radio, television, and mobile phones. There has been ongoing discussion in India, but no specific plan has been developed to install a Common Alerting Protocol as of today.

²⁰ OSDMA. 2019b. *Situation Report on Extremely Severe Cyclonic Storm - 'Fani'*. Date: 01.05.2019, Time: 6.00 PM.

²¹ GoO, World Bank, UN, and ADB. 2019. *Damage, Loss and Needs Assessment of Cyclone Fani*.



were warned and evacuated by special trains and buses. The ability to undertake timely evacuation to match the rapid intensification of the unusual cyclone outside the monsoon seasons proves the GoO's strengthened capacity for emergency preparedness and early warnings. The LBAS equipment as well as towers and poles installed to mount alert sirens did not experience any material damage from the cyclone.

24. **Digital mobile radios and satellite-based mobile data voice terminals (SBMDVTs) installed by the project were used for emergency communications during Cyclone Fani.** To provide uninterrupted emergency communications for the GoAP and GoO officials, the project installed 476 digital mobile radios and 34 SBMDVTs in the MPCs and EOCs and connected them with the respective state-wide area network, which was installed by the GoI through BSNL. Before the landfall of Cyclone Fani, the EOCs in Odisha used digital mobile radios for disseminating 1,275 alerts and coordinating emergency preparation activities between the state EOC and 30 district EOCs as well as between EOCs and the MPCs. After the landfall, the cyclone severely affected telecommunication infrastructure in the coastal districts with damages and losses estimated at INR 4.47 billion or US\$63.5 million.²² As telecommunication services became dysfunctional, EOCs could not use digital mobile radios for post-disaster emergency operations and relied on amateur radios for communication. However, the 14 SBMDVTs installed in Odisha effectively functioned and provided an emergency broadband connection for communication when all other communication networks failed in the aftermath of the disaster.

Outcome 2. Targeted coastal population having access to emergency shelters

AP – Revised Baseline 78%; Revised Target 88%; Actual 90%

Odisha – Baseline 30%; Revised Target 80%; Actual 82%

25. **The project constructed 535 MPCs in the coastal communities of AP and Odisha, providing shelter to the poor households, especially in vulnerable kutcha²³ houses.** The total design capacity of the MPCs built by the project in AP and Odisha is estimated at 127,425 people and 316,000 people respectively²⁴ although the actual peak occupancy can be higher as people use every space available during an emergency. The ground floor of some MPCs was designed to shelter livestock. The shelters were built in accordance with the national and state building codes, considering the needs of women and persons with disability (PWD), as discussed in section II.E. The PIUs appointed a TPQA for reviewing the designs and construction quality. As of April 2019, in total, there were 1,000 MPCs in AP²⁵ and 879 MPCs in Odisha,²⁶ of which the project contributed 22 percent and 36 percent, respectively. The shelters built by the state's own initiative adopted the project's multipurpose design principles.

26. **The construction of 1,087 km of rural roads and bridges provided the coastal communities with improved access to the MPCs.** Road construction and restorations involved the creation of missing road links to MPCs and core road networks such as national or state highways as well as construction or

²² GoO, World Bank, UN, and ADB 2019.

²³ *Kutcha* housing refers to dwellings that are constructed with thatched roofs or galvanized iron sheets.

²⁴ GoAP 2019 and GoO 2019.

²⁵ GoAP 2019.

²⁶ GoO, World Bank, UN, and ADB 2019.



restoration of culverts. With the construction of 535 MPCs and connecting roads and bridges, the project has improved accessibility to 90 percent in AP and 82 percent in Odisha²⁷, achieving the targets. Although the targets were revised at the time of the AF approval (see table 1), a split rating was not conducted for this ICR as the type of activities remained the same and the changes were made when only a small portion of disbursement had taken place.

27. While the project achieved 83 percent of targeted road length, the AP PIU has constructed 12 more bridges than the original estimate, effectively connecting some remote villages. As of April 2019, the project completed 34 bridges while one bridge was still under construction in AP with a physical progress of 84 percent due to re-designing required to accommodate the potential barge impact. The GoAP confirmed that the remaining work will be completed using the government's fund by August 2019.²⁸ The recommendations made by the TPQAs according to the IRC codes and site conditions were incorporated into the final engineering designs and construction of roads and bridges. The regular O&M of roads and bridges is budgeted and implemented by the respective state departments.

28. Nearly 55 percent of the roads constructed in AP (381 km) enhanced the transport connectivity of remote villages. The road alignments were selected to connect the target habitations with the core road network. Enhanced vehicular access ensures timely evacuation and fast deployment of emergency relief, materials, and machinery to the affected areas. For example, the improved connectivity enabled the APSDMA to operate buses for mass evacuation during Cyclonic Storm Phethai of 2018.

29. The project established 535 community-based MPCs Committees in AP and Odisha under the Societies Registration Act of 1860 to put in place a sustainable O&M mechanism. The AP PIU ensured that all the committees are run by women's self-help groups (SHGs). Each committee comprises 25 to 30 villagers and representatives of Gram Panchayats who are responsive to local needs. The GoAP and GoO approved a Government Order and established a community-based corpus fund of INR 500,000 (approximately US\$7,000) per shelter to provide financial support to the MPCs Committees in implementing regular O&M works. The funds will not be replenished by the states, but the interest earned from the funds (average 7.5 percent per year) and rental charged for private, commercial, or public uses of shelters are used by the MPCs Committees to finance the O&M works. The MPCs Committees facilitated evacuation of villagers and managed emergency supplies such as food and medicines at MPCs during Cyclone Fani. The focus group discussions (FGD) noted that the committees successfully facilitated equitable distribution of relief materials.²⁹ While the PIUs provided training on shelter maintenance and book keeping to all the MPCs Committees, the SDMA's are responsible for inspections and major repair works as needed before and after the monsoon seasons.

30. The MPCs were used for evacuation by coastal communities during the past cyclones, saving lives and protecting livestock. Before the landfall of the Extremely Severe Cyclonic Storm Phailin of 2013, the OSDMA conducted mock drills at all the MPCs and replaced equipment at many of the MPCs. All

²⁷ This takes into account the decadal population growth of 1.54 percent in AP and 11.8 percent in Odisha as per the 2011 population census.

²⁸ GoAP 2019.

²⁹ NDMA. 2018. *Benefit Monitoring Evaluation Report on National Cyclone Risk Mitigation Project*.



the 25 newly constructed MPCSS³⁰ were used to shelter approximately 25,000 people³¹ in Odisha during Cyclone Phailin, in addition to the partially completed MPCSSs. As of August 2014, the project had constructed 14 MPCSSs in AP and sheltered approximately 8,100 people³² during Cyclone Hudhud of 2014. During Cyclone Phethai of 2018, approximately 70,000 coastal residents in AP were evacuated to the MPCSSs built by the project.³³ Before the landfall of Cyclone Fani, the OSDMA advised the district collectors to evacuate all vulnerable people living in kutcha houses near the coast or in low-lying areas to the MPCSSs.³⁴ The OSDMA made arrangements for free kitchen, safe drinking water, lighting, health, and sanitation facilities at the MPCSSs before the landfall. About 274,500 people or 18 percent of the total evacuees in Odisha were housed in the project's MPCSSs. In addition, the APSDMA operated the EWDS during Cyclone Fani as the IMD's forecast initially included two coastal districts of AP. Nearly 4,100 people in AP were evacuated to the MPCSSs built by the project.³⁵ The roads and MPCSSs built by the project did not experience any material damage during the past cyclones and heavy rains in AP and Odisha.

Outcome 3. Agricultural land protected by strengthened or improved embankments

Baseline Zero; Target 30,000 ha; Actual 29,525 ha (98 percent)

31. **Approximately 29,525 ha of agricultural land in AP and Odisha are protected by 88 km of strengthened saline embankments.** About 49 percent of 2,000 households interviewed in the project areas engage in agriculture, fishery, and/or animal husbandry as the main occupation, of which 57 percent of people in AP and 74 percent in Odisha own their land. As they are located in low-lying areas, the coastal communities have experienced saline intrusion and widespread flooding of agricultural land because of storm surges during the 1999 Odisha Super Cyclone and the 2005 AP cyclone.³⁶ The project rehabilitated and strengthened 30 km of existing embankments in the Krishna delta of AP and 58 km of existing embankments in four districts of Odisha. The saline embankments were constructed in accordance with the Indian Standards codes and based on site-specific hydraulic and geotechnical studies taking into account the likely wave heights in the event of a cyclone of similar magnitude to the 1999 Super Cyclone³⁷ as well as the E&S impacts. The TPQA reviewed and ensured the engineering designs and construction quality of the embankments.

32. **Although the project reduced the intermediate results indicator on embankments from 180 km to 90 km at the time of AF, the project adopted an improved design.** The area of land and number of people to be protected by 180-km long embankments was not established at appraisal as detailed studies and final site selections had not been completed. The target length for Odisha (about 150km) was reduced by 60 percent while that for AP (about 30km) remained the same. At the time of AF, procurement and

³⁰ GFDRR. 2014. *Stories of Impact: Building Coastal Resilience in India*.

³¹ Assuming the average design capacity of 1,000 persons per unit.

³² Assuming the average design capacity of 580 persons per unit.

³³ GoAP. 2019. *ICR Report on NCRMP-I*.

³⁴ OSDMA 2019b.

³⁵ GoAP Revenue and Disaster Management Department. 2019. *Report on Usefulness/Effectiveness/Damage of Infrastructure Created under NCRMP during Cyclone Fani*. Lr. No. 0130/DM-NCRMP/SPIU/WB-NDMA/2017.

³⁶ World Bank 2010.

³⁷ Categorized by the IMD as a super cyclone with sustained maximum wind speed of up to 260 kmph in October 1999 (equivalent of Category 5 in Saffir-Simpson scale).



construction of embankments had not taken place. The project appropriately revised the target considering the available fund at the time of AF and the increased unit cost.

33. **The project established Embankment Surveillance Committees in both states to increase community ownership and timely identification of repair needs.** The embankments in AP are monitored by an existing farmer’s organization called the Krishna Eastern Delta Project Committee, while the embankments in Odisha are monitored by 47 surveillance committees (‘Luna Bandha Surakhya Samittee’) established by the project. The committees are responsible for reporting damages to the State Departments of Water Resources. The PIUs formulated a manual for regular surveillance and trained the committees based on similar experience in the Bank-supported Kosi River Basin project (P127725). The GoO established another corpus fund of INR500,000 per committee for financing surveillance and other related activities such as capacity building and community development. In AP, the Krishna Eastern Delta Project Committee utilizes its existing financial mechanism for surveillance. The State Departments of Water Resources are responsible for regular O&M works.

34. **During cyclones, the strengthened embankments protected the agricultural land from saline intrusion, protecting livelihoods.** According to a beneficiary survey with 2,000 households, about 79 percent of respondents in AP and 84 percent in Odisha reported that the loss of agricultural land has been minimized during the last cyclone in comparison to the pre-project stage.³⁸ In addition, an FGD with over 200 participants from 20 villages in Odisha and AP highlighted that the embankments (i) protected drinking water sources or wells from saline intrusion, (ii) safeguarded the villages and household properties, and (iii) provided access through the top of embankments during normal times and emergency. During Cyclone Fani, some areas experienced storm surge of 3.0 m to 4.6 m.³⁹ No major inundation of agricultural land occurred due to the storm surge although perennial crops were damaged by high winds.⁴⁰ The strengthened embankment did not experience any material damage.

Outcome 4. Increased awareness about warnings and emergency response

Baseline 30 percent; Target 100 percent; Actual 100 percent

35. **Annual mock drills and training of 535 village disaster management taskforces facilitated timely evacuation and strengthened the local search and rescue (S&R) and first aid capacity.** Since 2014, the SDMAs have used MPCSSs as a venue for conducting state-wide emergency mock drills every year on June 19. The project trained approximately 28,340 taskforce members in AP and Odisha on S&R and first aid in partnership with Red Cross. In AP, the PIU provided shelter management training in partnership with the Society for Elimination of Rural Poverty under the Department of Rural Development. A household survey indicates that all of 2,000 households interviewed in AP and Odisha were aware of warnings provided by the EWDS. An FGD also confirmed that the village-level S&R operations were improved and coordinated during the past cyclones, and highlighted that a sense of mutual support among community members was

³⁸ NDMA 2018.

³⁹ OSDMA 2019b.

⁴⁰ GoO, World Bank, UN, and ADB 2019.



nurtured through participation in training.⁴¹ There is growing empirical evidence that building connections within and among residents build community resilience by enhancing social capital.⁴²

36. **The coastal communities used the ‘MPCS kits’ provided by the project in times of emergency, strengthening the self-help capacity and mutual support among community members, reducing casualty.** The project supplied a kit for every MPCS, consisting of a generator set, basic rescue equipment, a water filter and tank, a first aid kit, and so on. The taskforces were trained in the use of the MPCS kit and deployed during Cyclone Fani, contributing to timely rescue and first aid support to the communities.⁴³ The taskforces paid special attention to vulnerable groups such as children, women, and PWD and arranged medicines for those in need.

Justification of Overall Efficacy Rating

Rating: Substantial

37. **The project played a substantial role in reducing the vulnerability of coastal communities in AP and Odisha.** As shown in table 2, the damage from cyclones in AP and Odisha has been reduced compared to the 1990s. Although the success in reducing the vulnerability of coastal communities cannot be solely attributed to the project, the EWDS, MPCS, and access roads built by the project were used during recent cyclones, contributing to timely evacuation. A study also shows that reducing the exposure of the poor through physical infrastructure such as embankments and roads and providing universal access to early warnings prevent well-being losses in times of disaster.⁴⁴

Table 2. Intensity of Historical Cyclones and Damage

Date	State	Damage	Maximum Sustained Wind Speed (kmph)
May 4–10, 1990 ^(a)	AP	Fatality of 967 people; loss of 3.6 million livestock; 14,000 houses damaged	235
November 4–7, 1996 ^(a)	AP	Fatality of 1,057 people; 174,000 ha of crops damaged	119
October 15–19, 1999 ^(a)	Odisha	Fatality of 205 people; 331,000 houses damaged; 158,000 ha of crops damaged	182
October 25–31, 1999 (Super Cyclone) ^(a)	Odisha	Fatality of 8,900 people; loss of 444,531 livestock	259
October 12, 2013 (Extremely Severe Cyclone Phailin) ^(b)	Odisha	Fatality of 50 people; loss of 6,644 livestock	220
October 12, 2014 (Very Severe Cyclone Hudhud) ^(c)	AP	Fatality of 61 people; loss of 5,874 livestock	182
May 3, 2019 (Extremely Severe Cyclone Fani) ^(d)	Odisha	Fatality of 64 people; loss of 3,673 livestock	175–180

Source: (a) World Bank 2010; (b) GoO, World Bank, and ADB. 2013. Joint Rapid Damage and Needs Assessment: Cyclone Phailin; (c) GoAP, World Bank, and ADB 2014; (d) GoO, World Bank, UN, and ADB 2019.

Note: kmph = kilometer per hour

⁴¹ NDMA 2018.

⁴² Aldrich, D.P. and Meyer, M.A. 2015. “Social Capital and Community Resilience.” *American Behavioral Scientist Vol 59, Issue 2.*

⁴³ GoO, World Bank, UN, and ADB 2019.

⁴⁴ World Bank. 2017. *Unbreakable: Building the Resilience of the Poor in the Face of Natural Disasters.*



C. EFFICIENCY

Assessment of Efficiency and Rating

Rating: Modest

Summary of Economic and Financial Analysis

38. **At appraisal, an economic and financial analysis (EFA) was carried out by establishing a vulnerability function to address the risk factor of the cyclone events.** The analysis set the discount rate at 10 percent over a timeframe of 10 years and the value of a statistical life (VSL) estimate of US\$150,000 purchasing power parity (PPP).⁴⁵ The analysis combined the cost of capacity building and EWDS with the MPCs because they are closely interlinked to facilitate evacuation. The results showed that the subproject on embankments and the subproject on MPCs and EWDS could achieve an economic rate of return (ERR) of 31 percent and 73 percent respectively for Odisha, with a positive benefit-cost ratio (BCR) of 2 and 4, respectively. Although the ERR of embankments for AP was not analyzed, that of the MPCs and EWDS was estimated at 28 percent with a BCR of 1.9.

39. **At AF, the analysis was premised on the hypothesis that the principal benefit of the overall risk mitigation investment would consist of the avoided damage cost because of project interventions.** The damage assessment from Cyclone Phailin was used as the baseline estimate. The focus of the economic analysis was on the scaled up activities. It was unclear whether the existing mitigation infrastructure was taken into account and the project benefits accounted for in an incremental manner. The life-span of these infrastructures was assumed to be 20 years. Under this assumption, the BCR for the MPCs was 6.4 at 5 percent discount rate and 3.9 at 10 percent discount rate. For roads and bridges, the BCR was 15.6 at 5 percent discount rate and 12.4 at 10 percent discount rate. The ERRs were not estimated.

40. **An ex post analysis was carried out and reestimated the ERR, BCR, and net present value (NPV) at completion.** The analysis is based on a retroactive analysis whereby project benefits were assumed to accrue gradually as investments were being completed. Due to paucity of data, a number of assumptions were adopted as discussed in annex 4. The ERR for MPCs and EWDS was reestimated at 53 percent and BCR at approximately 5 using a 6 percent discount rate and 4 using a 10 percent discount rate. The retroactive ERR model for embankments was built based on land saved from saline intrusion and thus protecting livelihoods. The ERR of embankments is estimated at 13 percent.

Aspects of Design and Implementation

41. **The extended project timeframe of almost eight years, improvement in designs, and other factors increased the unit costs.** At project closing, the actual unit costs of MPCs, roads, bridges, and embankments in Indian rupees (INR) increased by 59 percent, 47 percent, 87 percent, and 109 percent, respectively, compared to the estimates at appraisal.⁴⁶ Despite the increased unit costs, the improved designs provided enhanced benefits to the coastal communities as discussed in annex 4. The following

⁴⁵ Bhattacharya, S., A. Alberini, and M. Cropper. 2007. "The Value of Mortality Risk Reduction in Delhi, India." *Journal of Risk and Uncertainty* 34: 21–47.

⁴⁶ The original project costs were available in U.S. dollars only. The exchange rate at the time of appraisal (INR 46.17 per US\$) was used for the analysis.



factors contributed to the increased unit costs: (i) remoteness of the project sites and small civil contracts adversely affected the market appetite and resulted in less competition and high bid prices, (ii) increased cost of labor and materials over time, and (iii) difficulty in sourcing materials near the project sites.

42. The actual INR cost of Component A was higher than the original estimate by 54 percent while the actual INR costs of Components C and D were reduced by 28 percent and 18 percent, respectively.

The actual cost of Component A increased at project closing because of the changes in technological options adopted and the requirements for installing voltage stabilizers and other associated equipment during implementation. Although the project trained 86 percent of the targeted government officials, it efficiently delivered the planned outputs of Component C. While the project implementation experienced delay, the project management cost (Component D) was only 5 percent of the total actual project cost, implying administrative efficiency in achieving the outcomes. The current value of budget saving in Components C and D is estimated at US\$5.27 million.

43. The Project disbursed 85.5% of financing in SDR and undisbursed fund of SDR33.65 million was cancelled following the end of the grace period on May 31, 2019. The PMU and PIUs spent approximately 104 percent of the total commitment estimated in INR at the time of appraisal and AF⁴⁷ due to the exchange rate fluctuation in INR to USD.⁴⁸ Except for the internationally procured alert sirens, all the goods and works were procured by national competitive bidding. Although the unit costs increased in local currency, the INR depreciated enough that there were savings of SDR33.65 million (US\$48.15 million equivalent). Although cancellation of US\$20 million equivalent was considered at the time of Mid-term Review (MTR) in May 2013 due to savings from optimization of designs and currency fluctuations, it was not done as 90 percent of financing was committed by AF approval. It should be noted that due to exchange rate fluctuations between SDR and USD, the value of the IDA Credits expressed in USD terms decreased from US\$359 million to US\$333 million compared to the value at the time of approval.

44. An extension of 3.7 years was required to achieve the outcomes, affecting efficiency. The project achieved the original intermediate results indicators on MPCs 1.5 years after the original closing date⁴⁹ and on roads and embankments three years after the original closing date.⁵⁰ The installation of EWDS in AP was completed after the closing date. The factors that affected implementation are discussed in section III.B.

45. Despite the extended project timeframe, the task team leader turnover was low and did not affect implementation. The project ensured continuous implementation support as team members who had been involved in the project since preparation subsequently took over the leadership role.

46. The scaled-up outcome is considered to be reasonably commensurate with the AF. At project closing, the AF scaled up the construction of roads and MPCs, providing additional access to about 206,150 coastal residents and increasing the original outcome by 87 percent. While the AF was provided to increase the financing for MPCs and roads by 88 percent, the actual expenditure was 109 percent

⁴⁷ INR46.17/USD and INR61.98/USD respectively.

⁴⁸ It is of note that the PMU used a different exchange rate (INR52.45/USD) for the purpose of financial monitoring (94 percent disbursement).

⁴⁹ NDMA. 2016. NCRMP-I PSC Meeting held on December 28, 2016 - Minutes of the Meeting.

⁵⁰ NDMA. 2018. NCRMP-I 18th PSC Meeting held on August 17, 2018 - Minutes of the Meeting.



higher than the appraisal estimate due to the increased unit costs. Therefore, it is considered that the additional outcome was reasonably commensurate with the AF.

D. JUSTIFICATION OF OVERALL OUTCOME RATING

Rating: Moderately Satisfactory

47. The overall outcome is assessed as Moderately Satisfactory based on its relevance (High), the efficacy of the project to achieve the PDO (Substantial), and efficiency (Modest).

E. OTHER OUTCOMES AND IMPACTS (IF ANY)

Gender

48. **The project ensured equal participation of women and men in the design of MPCs and emergency preparedness and response capacity building.** The project incorporated feedback from the female community members into the design of the MPCs (for example, separate rooms and toilet facilities for women with consideration of menstrual hygiene, ramps for pregnant women, the elderly, and PWD). All the 535 MPCs Committees included female members, ensuring gender considerations in the O&M of MPCs. All the MPCs Committees in AP are run by women's SHGs who have acted as local implementing agencies for rural poverty alleviation and empowerment programs in AP since 1979.⁵¹ The project formed a network of 535 disaster management taskforces comprising youth volunteers with about 50 percent being women. The taskforces participated in annual mock drills and training on S&R and first aid. All the villages near the MPCs were mapped with demographic data, including specific information about pregnant women, elderly, children, and PWD for dedicated emergency support. The database is regularly updated by the governments. During Cyclone Fani, the GoO instructed the government officials to take special care of women in addition to the elderly, PWD, and children.⁵²

Institutional Strengthening

49. **The project contributed to institutional development of the NDMA, NIDM, and SDMAs under the federal system in line with the 2016 NDMP.** The 2016 NDMP states that the GoI aims to address several challenges to improve disaster and climate resilience, including institutional capacity building and generation and use of risk information. Building on the legal and institutional framework established under the 2005 Act, the project directly contributed to long-term institutional and technical capacity building of the NDMA, NIDM, and SDMAs in disaster management and emergency preparedness and response through Components A and C.

50. **The project's technical assistance augmented the NIDM's capacity in planning and promoting training and research in disaster management as defined in the Disaster Management Act of 2005.** The NIDM prepared its first comprehensive DRM capacity-building strategy based on an in-depth SWOT (strength, weakness, opportunity, threat) analysis of the country's legal, policy, institutional, and technical capacity and frameworks. The strategy developed under the project has been integrated into the NIDM's

⁵¹ World Bank. n.d. *India: Women's Self-Help Groups in Andhra Pradesh-Participatory Poverty Alleviation in Action*. (http://web.worldbank.org/archive/website00819C/WEB/PDF/CASE_-18.PDF).

⁵² Odisha State EOC 2019.



2013–2022 National Action Plan on Capacity Building. In addition, the NIDM prepared seven training of trainers (ToT) modules, covering multiple hazards and targeted priority sectors such as health, education, rural development, urban local bodies (ULBs), Panchayati Raj Institutions, and media. The NIDM prepared an operational plan for implementing the strategy. At the time of project closing, the NIDM had trained 475 master trainers in the state governments using the modules prepared under the project. The OSDMA plans to integrate the NIDM’s ToT modules into the state’s DRM capacity-building programs.⁵³

51. **The standard post-disaster needs assessment (PDNA) tools developed under the project helped the states conduct more accurate and transparent assessments of disaster damages and recovery needs.** In January 2017, the NIDM prepared the PDNA tools comprised of a handbook, manual, and standard operating procedures based on the feedback obtained during the National Consultation and Advocacy Workshop in May 2015. The NDMA plans to revamp the entire PDNA system according to the new PDNA tools, launch a web-based portal, and create a panel of experts for undertaking assessments. While the NIDM plans to roll out the PDNA tools for adoption by all the states under NCRMP-II (P144726), Bihar, Karnataka, Kerala, and Odisha have referenced the handbook for their recent PDNAs.

52. **A web-based cyclone hazard and risk atlas developed under Component C provided an improved understanding about cyclone risks.** The PMU developed the online atlas called the Composite Risk Atlas⁵⁴ in 2016 for decision makers in 13 states and UTs. The decision-support tool offers a comprehensive risk management framework for mitigation planning at the central, state, district, Taluka, ULBs, and village levels. The project prepared a manual and provided training to the state officials on the use of atlas. The GoO is currently updating its state and district disaster management plans by using the atlas.⁵⁵ The atlas provides a platform for undertaking dynamic and probabilistic risk assessment modelling under NCRMP-II. As Component C focused on the outputs (for example, number of officials trained, knowledge created), the PMU and NIDM plan to focus on application of the outputs (for example, providing training using the Atlas for risk-informed infrastructure planning and development) under NCRMP-II to further enhance the outcome.

Mobilizing Private Sector Financing

Not applicable.

Poverty Reduction and Shared Prosperity

53. **The project contributed to enhancing the resilience of poor households in Odisha and AP.** Disasters can induce and exacerbate poverty through the loss of lives; destruction of assets; disruption of economic activities and trade; and indirect impacts on health, mobility, gender equality, and access to education.⁵⁶ Approximately 11 percent of the rural population in AP and 36 percent in Odisha live below the poverty line.⁵⁷ About 16 percent of the state population in AP and 16.5 percent in Odisha are

⁵³ OSDMA 2019a.

⁵⁴ www.hrva.gov.in

⁵⁵ OSDMA 2019a.

⁵⁶ World Bank. 2017. *Unbreakable: Building the Resilience of the Poor in the Face of Natural Disasters*.

⁵⁷ Planning Commission. 2013. *Press Note on Poverty Estimates, 2011-12*.



Scheduled Castes (SCs) while about 6.6 percent of the state population in AP and 22 percent in Odisha are Scheduled Tribes (STs).⁵⁸ The project reduced the exposure of coastal residents by constructing embankments, reduced their vulnerability by establishing an early warning system and shelters, and improved their ability to cope with natural hazards through training on emergency response including first aid and S&R. During Cyclone Fani, some SC households were prevented by local community members from using shelters, but this issue was not observed in the MPCSS built by the project. This was enabled by the PIU's initiative to display usage rules at MPCSS clearly stating no discrimination and participation of SC and ST households in training and the MPCSS Committees.

54. **In addition to providing shelters during emergency, the MPCSS serve as venues for multiple social functions for local communities and governments.** An FGD⁵⁹ with over 200 participants from 20 villages in Odisha and AP highlighted that the MPCSS are used as venues for Panchayat (village council), district, and women's SHG meetings; social functions such as weddings and village ceremonies; public health such as Anganwadi centers⁶⁰ and clinics; educational purposes including classrooms and training centers; and polling places. The FGD highlighted that the multipurpose nature of shelters is effectively functioning as a hub for community mobilization and cohesion, enhancing social capital.

55. **More than half of the roads and bridges constructed and repaired by the project enhanced the connectivity of remote villages in addition to improving their access to the MPCSS and emergency transportation.** The roads and bridges constructed and repaired under the project linked some remote villages with the core road network. The benefits highlighted by the household survey include improved access to markets, schools, medical centers, and emergency transportation such as relief and ambulances.⁶¹ For example, a bridge constructed in the Krishna District saves 30 minutes of travel time from a remote island to the district headquarters in addition to catering to the evacuation needs of approximately 150,000 people living in the vicinity.⁶² Previously, the villagers living in the island commuted to the district headquarters by boat. Furthermore, the tops of embankments serve as roads.

Other Unintended Outcomes and Impacts

56. **The use of geospatial tools, including Geographic Information System (GIS) for environmental screening created a new standard for World Bank projects in India.** The screening tool allows the identification and management of risks in projects with geographically dispersed investments across ecologically sensitive and challenging landscapes. The tool helped avoid site selection in environmentally sensitive areas, strengthened the project's environmental monitoring systems, and substantially reduced the requirements for triggering regulatory clearances. Pioneered by the project, the approach and methodology have been used as a decision support tool in a number of World Bank-funded projects in

⁵⁸ GoI. 2011. *Population Census*.

⁵⁹ NDMA 2018.

⁶⁰ Anganwadi centers provide basic health care in villages as part of public health care system. Basic health care activities include contraceptive counseling and supply, nutrition education and supplementation, as well as preschool activities.

⁶¹ NDMA 2018.

⁶² GoAP 2019.



India, increasing efficiency, accuracy, and timeliness of environmental management decisions at the early planning stage of the project cycle.

57. **The project supported the CPF's Lighthouse approach by disseminating its experience and knowledge with other states.**⁶³ The project informed the development of NCRMP-II which covers the coastal states of Goa, Gujarat, Karnataka, Kerala, Maharashtra, and West Bengal. The regular Project Steering Committee (PSC) meetings and site visits, jointly held among the PMU and PIUs from the Phase-I and Phase-II states, enabled the timely dissemination of experience and lessons learned among the participating states. The project disseminated its experience and lessons learned with a wider audience through online publication of three knowledge notes⁶⁴ in collaboration with the Global Facility for Disaster Reduction and Recovery.

III. KEY FACTORS THAT AFFECTED IMPLEMENTATION AND OUTCOME

A. KEY FACTORS DURING PREPARATION

58. **The project set the PDO at the right level of ambition and scope.** As the project was the World Bank's first DRR project in India, adopting a multi-hazard approach for tackling both hydrometeorological and geophysical hazards such as earthquakes was considered too ambitious. Therefore, the project targeted hydrometeorological risk mitigation with a focus on cyclones. As the IMD completed the first phase of a program for modernizing its meteorological forecasting systems in 2010, it was an appropriate time for the project to focus on early warning systems as the IMD augmented its capacity.

59. **The project selected appropriate stakeholders and beneficiaries with due consideration of readiness for implementation.** While there are 10 coastal states in India that are exposed to cyclones, the project selected AP and Odisha, which were classified as Higher Vulnerability Category I states. The project did not select the other Category I states (that is, Gujarat, Tamil Nadu, and West Bengal) considering their institutional and implementation readiness at appraisal. Also, the project was tailored to the newly established DRM institutional arrangements based on the 2005 Act where the PMU is established within the NDMA and the State PIUs in the SDMAs, effectively contributing to institutional strengthening of national and state DRM agencies that were still in their infancy at the time of appraisal.

60. **The project adopted a simple design reflecting lessons learned from the Indian Ocean Tsunami.** Immediately after the Project Concept Review meeting in mid-December 2004, the Indian Ocean Tsunami struck AP, Tamil Nadu, Puducherry, and Kerala with total damage and losses estimated at US\$1 billion. At the request of the GoI, the Bank prioritized the support to Tamil Nadu and Puducherry through the Emergency Tsunami Reconstruction Project (P094513). During 2008 to 2010, the Bank resumed project preparation at the request of the GoI, reflecting the lessons learned from the reconstruction project such as a fewer subprojects and implementing agencies for a simple design.⁶⁵ This helped the PMU efficiently coordinate with and provide targeted support to the PIUs and implementing agencies.

⁶³ 'Lighthouse India' involves analyzing, curating, and disseminating the country's vast experience and knowledge internally between states and externally with the rest of the world.

⁶⁴ See annex 6 (supporting documents).

⁶⁵ World Bank. 2012. *ICR on Emergency Tsunami Reconstruction Project*. Report No: ICR00002215.



B. KEY FACTORS DURING IMPLEMENTATION

61. **The signing of the original FA and that of the AF were delayed due to political and administrative factors.** While the original project was approved by the Board on June 22, 2010, the FA was signed on January 14, 2011, and it became effective on March 30, 2011. This delayed the implementation for almost nine months as both states were hesitant to award contracts for civil works despite initiating procurement actions during the first year. Also, while the AF was approved by the Board on April 8, 2014, the FA was signed on August 11, 2015, as the cabinet clearance was delayed until July 2015 because of an ongoing discussion on SDR exchange rates, putting on hold the World Bank's entire India portfolio at that time.

62. **Procurement and contract management factors affected the civil works.** The PIUs, especially in AP, experienced the following challenges that contributed to extensive rebidding of Component B and implementation delays: (i) a lack of market appetite for small civil works in remote areas; (ii) high bid prices owing to the remoteness; and (iii) a transition to the e-procurement system of the National Informatics Center (NIC) in 2013, which required training of the contractors and line departments. Although the introduction of e-procurement resulted in a hiatus of procurement for at least six months, it has improved transparency and standardized the process. Also, the PIUs faced a challenge in sourcing construction materials for embankments and identifying appropriate land for some MPCs.

63. **The completion of EWDS was delayed due to procurement and technical challenges.** The delay in Component B affected the progress of Component A because some of the alert sirens and radios were planned to be installed in the MPCs.⁶⁶ The terms of reference for supply and installation of the EWDS equipment did not clearly describe the associated infrastructure and equipment required to be built, further delaying installation of the EWDS. In AP, the alert sirens were installed in remote coastal villages with voltage fluctuations which could damage the sirens. In coordination with the State Electricity Board, the PIU has installed voltage stabilizers to provide a regulated power supply.

64. **The environmental permitting process involving CRZ clearances for civil works took considerable time, especially in AP.** The CRZ Notification of 1991 was updated by the Ministry of Environment and Forests in January 2011 with special provisions for the Krishna Delta where the embankments and other civil works in AP were planned. It was the first time for the AP PIU to obtain CRZ clearances according to the 2011 Notification, which was passed after the appraisal phase, and delayed the implementation for six to eight months. However, the PIU gained experience through the process and there was no delay in obtaining permits under the AF.

65. **The frequent natural disasters and bifurcation of AP affected implementation.** The coastal areas of AP and Odisha were hit by several natural hazards including the Extremely Severe Cyclonic Storm Phailin of 2013, Very Severe Cyclonic Storm Hudhud of 2014, Very Severe Cyclonic Storm Titli of 2018, and Cyclonic Storm Phethai of 2018. Being established within the SDMA, the PIUs engaged in emergency preparation, response, and recovery works. Bifurcation of the state into AP and Telengana under the Andhra Pradesh Reorganization Act of 2014 and the subsequent administrative transition significantly

⁶⁶ Office of the Director General of Audit. 2018. Inspection Report of World Bank assisted NCRMP IDA Credit No. 4772-IN, 5413-IN, and 5693-IN under NDMA, MoHA for the period 2017-18.



slowed implementation and procurement of civil works in AP during 2013 and 2014. As the coastal districts remained in AP, restructuring was not considered.

IV. BANK PERFORMANCE, COMPLIANCE ISSUES, AND RISK TO DEVELOPMENT OUTCOME

A. QUALITY OF MONITORING AND EVALUATION (M&E)

M&E Design

66. **While presenting a ToC was not mandatory at the time of appraisal, key activities and outputs were sound and well linked with outcomes.** The PDO clearly specified the targeted beneficiaries in AP and Odisha. Although the intended benefit was not entirely measurable as the definition of vulnerability encompasses a variety of concepts and elements including sensitivity to harm and lack of capacity to cope and adapt,⁶⁷ the PDO was well aligned with the actual interventions. The indicators were specific, achievable, and relevant. However, the PDO indicator on the 'proportion of the targeted coastal population covered by the EWDS' was difficult to accurately monitor the progress without the use of GIS. The baseline and target value for the PDO indicators on strengthened embankments and the level of awareness about warnings and emergency response were not established as the feasibility studies, designs, costing, and household surveys were not completed at the time of appraisal.

67. **The indicators were adequate to capture the contribution of the project's activities and outputs toward achieving the PDO-level outcomes.** The indicators adequately encompassed the key outcomes of the PDO statement. The PDO indicator on awareness could have adopted a quantitative target. Considering the multiple co-benefits of investments (for example, multipurpose nature of shelters, enhanced connectivity of remote villages, women's empowerment), the project could have added a PDO indicator to measure the project's contribution to improving people's well-being and reducing socioeconomic vulnerability. Although the results framework could have been improved to monitor and encourage the utilization of knowledge created under the Component C, the states' decisions for risk-informed planning and investments were beyond the control of TA.

68. **As part of Component D, the project designed a benefit monitoring and evaluation (BME) study.** The objectives of the BME study were to establish the baselines for MPCs accessibility and awareness about warnings, facilitate midterm corrections, and measure the outcomes at the end of the project through a household survey. Each survey covered 2,000 households from 109 coastal villages in AP and Odisha representing 5 percent of the total coastal residents. The study interviewed the same households at midterm and end term to monitor and evaluate the project's outputs and outcomes according to the Results Framework. The BME study could have been designed to include a cost-benefit analysis (CBA).

69. **The project management information system (MIS) was well designed in providing uninterrupted real-time access to reliable and accurate information with clearly mapped roles and rights of responsible entities.** The system covered procurement, financial management (FM), physical progress, a grievance redress mechanism (GRM), and key information on E&S aspects and enabled effective functioning of various units. The Project Operation Manual outlined the data and information to

⁶⁷ Intergovernmental Panel on Climate Change. 2014. *Fifth Assessment Report on Impacts, Adaptation, and Vulnerability*.



be entered in the MIS and required regular progress reports to be prepared by the PMU and submitted to the Ministry of Home Affairs (MoHA) and the Bank.

M&E Implementation

70. **The MIS and monitoring arrangements were institutionally well embedded in the PMU and PIUs.** The PIU's MIS specialists sufficiently managed the project information and submitted monthly progress reports to the PMU and presented the progress at the PSC meetings headed by Secretary NDMA and attended by the PMU, representatives of PIUs, and the Bank. The project established an online MIS in 2011 with support from the NIC, but it was not fully functional until revamping in 2013 due to some technical problems such as user friendliness. During the revamping process, the PIUs and PMU used an offline MIS (for example, spreadsheets). At project closing, the SDMAs still maintained the MIS functions for managing project information including the GIS-based asset database.

71. **The project carried out the planned baseline data collection.** The PMU appointed an external consultant to carry out the BME study. The baseline value for people's awareness about warnings was established through the BME study in June 2010. The baseline and target values for strengthened embankments were separately established in 2014 at the time of AF when the feasibility studies and designs were finalized.

72. **The PMU and PIUs ensured attention to effective monitoring and reporting, but placed less emphasis on outcome evaluation.** The project's progress against the intermediate results indicators was regularly monitored and reported by the PIUs and PMU at the PSC meetings. The PMU monitored the outcomes through the BME study including a midterm survey in March 2014 and an end-term survey in December 2017. It is considered that the end-term survey essentially captured the final outcomes as the project had completed 89 percent of the MPCSSs, 86 percent of road works, and 98 percent of embankment works at the time of survey.⁶⁸ In addition to the three structured interview surveys with 2,000 households, 20 FGDs and 50 key informant interviews were conducted as part of the BME study and qualitatively identified the unintended outcomes. However, most of the information collected from the households focused on their perceptions about the project activities rather than quantitatively monitoring and evaluating the actual outputs and outcomes according to the Results Framework.

73. **The PDO indicators included in the Results Framework were measured and reported in the Implementation Status and Results (ISR) Reports.** However, there was discrepancy between the target values adopted in ISRs and the Results Framework (see annex 1). Also, intermediate results indicators for Components A and C were not measured and reported in the ISRs. At the time of third restructuring, the project could have updated the intermediate results indicators on: (i) the EWDS as the target value became irrelevant to the corresponding PDO indicator with advancement of technology; (ii) the road length considering the additional bridges constructed; and (iii) the bridges as they were not included in the results framework but constituted 14 percent of the total actual costs at closing.

M&E Utilization

⁶⁸ NDMA. 2018. NCRMP-I 17th Project Steering Committee Meeting held on January 19, 2018 - Minutes of the Meeting. No. 1-1/2012-NCRMP (Vol. IV)/2174.



74. **The monitoring data were communicated to the various stakeholders and utilized to inform project management and decision making by the PSC.** Access to real-time information through the online MIS helped the PMU and PIUs identify and implement corrective measures to address the delays and non-compliances. The PMU and PIUs held 20 PSC meetings since November 2012 and discussed the project's performance and progress against the outputs, key challenges, and actions by the PIUs. In addition, the PMU publicly disclosed the project's monitoring information including the PSC meeting minutes and financial status through the project website.⁶⁹ However, the M&E data was used to provide evidence of achievement of outputs, rather than outcomes.

75. **The BME's midterm survey and two JRDNA's were used to improve the project designs and informed the AF.** The NDMA, SDMA's (including the members of the PIUs), and the Bank team jointly conducted damage and needs assessments of Cyclone Phailin of 2013 that hit Odisha and Cyclone Hudhud of 2014 that hit AP. The recommendations to strengthen the state's DRM capacity were made based on the assessments, reflected in the MPC's designs, and informed the scaled-up activities through the AF.

Justification of Overall Rating of Quality of M&E

Rating: Substantial

76. **The M&E system was generally sufficient to assess the achievement of the objectives and test the links in the results chain, and the findings were utilized to inform the subsequent operation.** The project's ToC was clear and adequate indicators were identified to monitor progress towards achieving the PDO although there was a delay in establishing the baselines and targets for two PDO indicators. The project's online MIS and regular PSC meetings effectively functioned to monitor the progress, identify key issues, develop actions, and inform NCRMP-II. However, the project could have improved the M&E methodology and analysis to provide evidence of achievement of outcomes.

B. ENVIRONMENTAL, SOCIAL, AND FIDUCIARY COMPLIANCE

77. **Safeguards.** The project was classified as Category A and triggered four policies: Environmental Assessment (OP/BP 4.01), Physical Cultural Resources (OP/BP 4.11), Involuntary Resettlement (OP/BP 4.12), and Indigenous Peoples (OP/BP 4.10). At appraisal, the project prepared an Environmental and Social Management Framework (ESMF), a Resettlement Policy Framework, and an Indigenous People's Instrument. The environmental impacts were largely associated with the construction of buildings, roads, and repairs of the existing embankment as well as installation of towers and poles for mounting alert sirens. These included impacts on vegetation, drainage, air quality, noise levels, and occupational health and safety. The expected social impacts included temporary livelihood disturbances associated with the construction and a modest loss of land. During implementation, the project's overall safeguards performance was rated Moderately Satisfactory to Satisfactory.

78. **The E&S risks and impacts were screened, assessed, and mitigated in accordance with the national and state legislations and the Bank's safeguard policies.** The PIUs carried out a screening assessment of each subproject by using GIS. This enabled environmentally and socially appropriate site selection and avoided the significant adverse impacts in advance at the planning stage. Owing to the appropriate site selection, the project did not result in removal of physical cultural resources nor affect

⁶⁹ <https://ncrmp.gov.in/>.



critical ecosystems. An Environmental and Social Impact Assessment was carried out for subprojects with potential adverse impacts. Before commencement of civil works, the PIUs obtained regulatory approvals including CRZ clearances and required preparation of subproject EMPs in bidding documents. Site restoration and mangrove plantations were implemented after the construction phase. Regular independent audits carried out by the TPQAs found no significant negative E&S impacts, and helped the PIUs implement the required actions on time.

79. **The PIUs planned and implemented civil works in accordance with the Indigenous People's Instrument and OP/BP 4.10.** While the project's target coastal population included some population of STs, the project activities did not result in any adverse impact on the STs and no grievances were received during implementation.

80. **The project did not result in involuntary resettlement.** Land acquisition from only one household was required in the case of bridge construction in AP. The PIU prepared an abridged Resettlement Action Plan (RAP) and compensated the affected household in accordance with OP/BP 4.12. In all other cases, small strips of land were made available through voluntary land donation. There was a strong willingness to donate as the project would enhance the community's resilience to natural hazards. The RAPs were prepared and Memoranda of Understanding were signed between the State Governments and the individuals who donated their land.

81. **A GRM was established in both states building on the state's existing systems in accordance with OP/BP 4.01.** The GRMs were in place at the field level and aggregated in the MIS managed by the PMU. The grievances received were minor in nature and mostly addressed at the field level. Stakeholder consultations were adequately conducted throughout implementation. Based on the Bank's advice, the PIUs trained around 40 community mobilizers for stakeholder engagement and consultations, contributing to timely information sharing and prompt redressal of the grievances.

82. **Procurement.** The project's procurement performance was rated Moderately Satisfactory to Satisfactory during implementation. The Procurement Plans were updated and published every 12 to 18 months in accordance with the Procurement Manual. There was an inconsistency between the Bank's procurement policies and AP's state procurement regulations. This resulted in extensive rebidding and delays in awarding contracts even when the bids were found to be acceptable according to the Bank policies. Also, there were a few occasions in both states where contracts were awarded beyond the bid validity period and formal extensions of contracts were absent. While the process for implementing corrective actions took considerable time, the PIUs' capacity for complying with the Procurement Manual gradually improved with experience.

83. **FM.** The project's FM performance was rated Moderately Satisfactory to Satisfactory during implementation, except in 2012 due to the delay in submission of FY11-12 audit report by PMU. The project ensured adequate institutional FM arrangements and control procedures with appointment of FM specialists in PMU and PIUs as well as internal and external auditors. External audits were prepared on time throughout implementation and made several qualified opinions, including the Odisha PIU's financial reporting and accounting practices (for example, asset register maintenance and Books of Accounts) in FY15-16 and FY16-17 as well as a questionable expenditure of INR380 million (approximately US\$5.5 million) in the AP PIU's FY10-11 to FY16-17 financial statements. While the Odisha PIU rectified the issues, corrective action by the AP PIU was pending at project closing. As per the FM Manual, the project adopted



the planned flow-of-fund arrangements through reimbursement by the Bank based on the Interim Unaudited Financial Reports (IUFs) submitted by the PMU. The IUFs included 75 percent of Component B's actual expenditure and the rest was financed by the counterpart funding as per the FA.

C. BANK PERFORMANCE

Quality at Entry

84. **The Bank identified an area of support that is of critical importance for India's ability to respond to the risk of increasingly frequent cyclones.** The project design targeted interventions that addressed priority technical capacity gaps in mitigating cyclone risks in NDMAs and SDMAs. A second operation was launched in 2014 covering the rest of the coastal states with the same implementation arrangements. The project's strategic relevance and approach laid the foundation for the Bank's subsequent DRM engagement in India.

85. **Lessons learned from the past reconstruction activities and existing studies informed the project design.** The preparation timeframe of six years ensured that the project design reflected the evolving DRM governance system in India and lessons learned from the past reconstruction activities in Bangladesh⁷⁰, AP⁷¹, Tamil Nadu, and Puducherry. As the challenges associated with the inconsistency between the AP's state regulation and World Bank policies on procurement were recognized, a Procurement Manual was prepared to ensure consistency and adherence to the Bank policies and agreed procedures. The Bank reviewed the existing studies on the EWDS and opted for more robust and efficient GSM-based technology over the then prevalent very high frequency radio technology.

Quality of Supervision

86. **The Bank proactively identified and resolved technical challenges to ensure development impact.** The Bank swiftly provided support to the GoO and GoAP on a JRDNA of Cyclones Phailin and Hudhud, reducing the disruptions to the project implementation. The Bank ensured that lessons learned from Cyclone Phailin were captured to improve the MPCS designs (for example, ensuring the open spaces on the ground floor remain dry during cyclone events, protection of walls and openings during heavy rains by the use of continuous eaves). Also, as there was an increasing number of lightning incidents across India, the Bank advised PIUs to install lightning arresters in every MPCS. The Bank reviewed the TPQA reports and made recommendations to ensure that the civil works were appropriately designed and constructed with structural integrity. This was enabled by forming a task team specialized in civil, hydraulic, and architectural engineering. The Bank could have strengthened its internal capacity on the EWDS to help expedite the implementation of Component A, which was largely dependent on the knowledge partner appointed by the PMU.

87. **The Bank provided adequate supervision to PIUs and the PMU throughout implementation despite the low frequency of the ISRs.** Although there were six gaps of 8 to 12 months between ISRs, the Bank regularly participated in PSC meetings and used opportunities to conduct field visits through other ongoing DRM projects in Odisha and AP (P148868 and P154847) since 2014 and 2015 respectively to

⁷⁰ Emergency 2007 Cyclone Recovery and Restoration Project (P111272).

⁷¹ World Bank. 2003. *ICR Report on AP Hazard Mitigation and Emergency Cyclone Recovery Project (Report No. 26673)*.



discuss the project's progress. The Bank prepared four Aide Memoires based on field visits without the accompanying ISRs. In addition, the Bank provided technical advice to the NDMA and NIDM especially on Component C as it was the country's first initiative to develop a cyclone risk assessment model and standardize the PDNA. Through JRDNAs, the Bank provided hands-on technical support to the government officials on implementing the standard PDNA methodology. The Bank could have more accurately reported the project's progress against the Results Framework in ISRs as discussed in section IV.A.

88. **The Bank regularly provided training to PIUs and reviewed the safeguard and fiduciary arrangements.** Recognizing the risk to sustainability of outcomes and to expedite implementation, the Bank adequately provided advice related to safeguards. The MTR in 2013 provided an opportunity for the PMU and PIUs to develop an action plan for accelerating implementation and resolving outstanding procurement issues. After the MTR, implementation accelerated with 90 percent of the original credit committed at the time of AF preparation in 2014. The Bank trained the PIUs on procurement, regularly reviewed, and made recommendations to minimize the inconsistency between the AP's regulation and the Bank's policies based on the lessons learned from the past activities in AP (for example, rationalizing qualification requirements, repackaging to suit market conditions, bringing in appropriate factors in the pre-bid estimate). The Bank regularly reminded the PIUs about the qualified opinions and was awaiting the final audit at project closing.

Justification of Overall Rating of Bank Performance

Rating: Moderately Satisfactory

89. **The Bank provided adequate and sound technical advice to solve challenges and ensure the quality of interventions.** The Bank strategically identified and facilitated preparation of the project. While the Bank team possessed high technical expertise in providing implementation support to Components B and C, it largely depended on the PMU's knowledge partner for Component A. The Bank's reporting had shortcomings, but supervision was adequately provided through PSC meetings and at least biannual field visits. The Bank reviewed and provided advice to solve the procurement challenges during implementation. The Bank's advice to use a GIS for E&S screening assessment and to involve local communities for infrastructure maintenance contributed to enhancing the sustainability of outcomes beyond the framework of risk management.

D. RISK TO DEVELOPMENT OUTCOME

90. **Natural hazards could damage power and telecommunication infrastructure, adversely affecting emergency communications.** Without building redundancy and enhancing robustness of power and telecommunication infrastructure such as power plants, substations, transmission and distribution lines, and telecommunication towers, the EOCs and EWDS equipment such as digital mobile radios can be disrupted due to power outage and limited telecommunication coverage.

91. **Due to climate change, the increased frequency and intensity of hydrometeorological hazards may pose a risk to the structural integrity of infrastructure.** The roads, bridges, embankments, and MPCs were built in accordance with the national design standards and taking into account the intensity and frequency of historical cyclones. While the project ensured a sustainable system for community-based infrastructure maintenance through the establishment of corpus funds, major O&M works including proper inspections, rehabilitation and upgrades will need to be budgeted and implemented by the line



departments with sufficient technical expertise and knowledge. For example, some of the old embankments built by the state's own initiative were damaged during Cyclone Fani due to a lack of proper maintenance. Without the state's regular O&M works, the risk mitigation infrastructure built by the project can easily deteriorate due to aging and natural hazards.

V. LESSONS AND RECOMMENDATIONS

92. **Capacity building of local communities maximizes the benefits of infrastructure investments and directly contributes to reducing the vulnerability of communities.** Investments in cyclone shelters, access roads, and early warning systems alone do not automatically lead to reducing the vulnerability of communities if people are not aware about early warnings and actions to take. Frequent mock drills increase people's awareness about evacuation in response to warnings about natural hazard events. Also, establishment and training of community-based emergency taskforces enable timely emergency response especially for those living in remote areas where the Government's intervention generally takes time to reach. Involving the vulnerable groups such as women, the elderly, children, STs, and SCs in training enables inclusive disaster preparedness, contributing to the GoI's goal of 'zero casualty' in times of natural disaster.

93. **While community-based infrastructure management increases a sense of ownership and timely identification of repair needs, it is increasingly critical that the governments put in place a climate-resilient asset management system.** Establishing a community-based committee puts in place a sustainable local mechanism for managing infrastructure assets, and provides a sense of collective responsibility for surveillance and maintenance. Under the World Bank-funded NCRMP-II, the GoI is working with all the coastal states to replicate the model of community participation and ownership around critical infrastructure. In addition, integrating climate resilience into infrastructure designs and O&M is increasingly critical in the context of climate change as the frequency and intensity of hydrometeorological events is likely to increase. This will require sustainable budgeting and adequate technical capacity of local governments and contractors in designing resilient infrastructure and carrying out timely inspections, repairs, rehabilitation, and upgrades for resilient asset management.

94. **Smooth implementation requires comprehensive procurement planning and good governance.** Preparation of a thorough and realistic Project Procurement Strategy for Development could identify sourcing risks and supply bottlenecks related to construction materials and to propose appropriate mitigation measures to avoid downstream delays. Market intelligence helps assess contractor availability and capabilities upfront and contributes to designing appropriate procurement packages and methods, especially for small, geographically dispersed works in remote areas. The local contexts and subproject-specific requirements (for example, transportation cost and materials availability) need to be carefully analyzed and realistically reflected in cost estimates in addition to the Schedule of Rates published by governments. Proper sequencing of tasks in the procurement plan and prioritization of critical procurements can help mitigate the impact of delay in one component to the other.

95. **As technology will continue to rapidly advance, the best available technology at the time of appraisal requires thorough reviews and reinvestigation during implementation.** It is difficult to identify the perfect EWDS technology in terms of reliability and cost effectiveness as it continues to evolve. With advancement of technology, some intermediate results indicators could become obsolete during



implementation as the underlying technological assumptions change. It is recommended to regularly review the relevance and impact of best available technological solutions for achieving the intended outcomes.

96. **Effective emergency communications in times of disaster require building the redundancy and robustness of telecommunication and electric power infrastructure.** Electricity transmission and distribution lines and telecommunication towers can be damaged by a natural hazard, adversely affecting emergency communications. Building the resilience of power and telecommunication infrastructure would require enhancing the structural integrity of the critical assets such as power plants, substations, transmission and distribution lines, and telecommunication towers as well as providing backup power supply at EOCs and shelters. Adopting various telecommunication technologies such as cellular network, radio, and satellite contributes to building the system redundancy.



ANNEX 1. RESULTS FRAMEWORK AND KEY OUTPUTS

A. RESULTS INDICATORS

A.1 PDO Indicators

Objective/Outcome: To reduce vulnerability of coastal communities in AP and Odisha to cyclone and other hydromet hazard

Indicator Name	Unit of Measure	Baseline	Original Target	Formally Revised Target	Actual Achieved at Completion
Proportion of the targeted coastal population covered by the Early Warning Dissemination systems	Percentage	0.00	100.00	100.00	100.00
		22-Jun-2010	30-Apr-2015	31-Dec-2018	31-Dec-2018

Comments (achievements against targets):

The Project installed 275 alert sirens with an area of influence of 1.5 to 2km radius each, covering all the vulnerable coastal villages. The sirens were installed at MPCs, District and Block Emergency Operation Centers (EOCs), fish landing centers and popular tourist sites. The total coverage of alert sirens is 4.17 million coastal residents in AP and Odisha. In addition, the Odisha PIU integrated the location-based alerting system (LBAS) with BSNL, India’s state-owned telecommunications company. Approximately 3.75 million BSNL subscribers in Odisha as of June 2019 can receive warnings via short message service (SMS), including about 80% of the coastal residents (928,700 people).

Indicator Name	Unit of Measure	Baseline	Original Target	Formally Revised Target	Actual Achieved at Completion
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Proportion of coastal community having access to emergency shelters	Percentage	61.00 22-Jun-2010	78.00 30-Apr-2015		87.00 31-Dec-2018
In Odisha	Percentage	30.00 22-Jun-2010	60.00 30-Apr-2015	80.00 31-Dec-2018	82.00 31-Dec-2018
In AP	Percentage	78.00 22-Jun-2010	98.00 30-Apr-2015	88.00 31-Dec-2018	90.00 31-Dec-2018

Comments (achievements against targets):

At appraisal, the project estimated that the proportion of people having access to emergency shelters was 30% (160,000 people) within 10km from the coastline of Odisha and 78% (780,000 people) within 10km from the coastline of AP. Therefore, the number of coastal residents without access to emergency shelters was 1 million in AP and 533,000 in Odisha. With construction of 219 MPCs in AP and 316 MPCs in Odisha and construction of connecting roads and bridges, the Project has improved people's accessibility to 90% in AP and 82% in Odisha. This takes into account the decadal population growth of 1.54% in AP and 11.8% in Odisha based on the Gol's 2011 population census data. It should be noted that the original targets were 98 percent for AP and 60 percent for Odisha and these were revised at the time of AF with additional construction of MPCs and the re-estimated baseline for AP. Although the official results framework revised at the time of AF includes only the state-wise indicators, the ISRs reported on both the state-wise and total combined proportion of people having access to MPCs in AP and Odisha. As the ICR datasheet is linked with the final ISR issued in January 2019, it was not possible to correct this at the time of ICR.

Indicator Name	Unit of Measure	Baseline	Original Target	Formally Revised Target	Actual Achieved at Completion
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Coastal People protected by strengthened / improved embankments	Number	0.00 22-Jun-2010	1900000.00 31-Oct-2017	1900000.00 31-Dec-2018	1869900.00 31-Dec-2018
Number of people protected	Number	0.00 22-Jun-2010	1900000.00 31-Oct-2017	1900000.00 31-Dec-2018	1869900.00 31-Dec-2018
Hectares of land protected by strengthened/improved embankments	Number	0.00 22-Jun-2010	30000.00 31-Oct-2017	30000.00 31-Dec-2018	29525.00 31-Dec-2018

Comments (achievements against targets):

The targets were established in 2014 in consultation with the PIUs based on the number of coastal residents within the floodplains, detailed engineering designs, and topographic surveys using the updated targets on 90km of embankments and 30,000 ha of protected land at the time of AF. Considering that the strengthened embankment covers 98% of target floodplain, about 98% of targeted 1.9 million people (1.87 million people) are protected by the embankments. This may be a conservative figure considering the decadal rural population growth in Andhra Pradesh at 1.54% and in Odisha at 11.8% according to the 2011 Census. The project protected 29,525 ha of agricultural land or 98% of the target. It should be noted that the ISRs reported on the number of people protected since June 2014 although it was not included in the official results framework revised at the time of AF. As the ICR datasheet is linked with the final ISR issued in January 2019, it was not possible to correct this at the time of ICR.

Indicator Name	Unit of Measure	Baseline	Original Target	Formally Revised Target	Actual Achieved at Completion
Increased awareness about	Percentage	30.00	100.00	100.00	100.00



warnings and emergency response		22-Jun-2010	30-Apr-2015	31-Dec-2018	31-Dec-2018
<p>Comments (achievements against targets): A household survey conducted in 2010 established the baseline at 30% based on an interview survey of 2,000 households in AP and Odisha. The end-term survey conducted in December 2017 indicates that the awareness of the same interviewees was increased to 100%. Annual mock drills and training of 535 village disaster management taskforces facilitated timely evacuation in times of disaster and strengthened the local search and rescue and first aid capacity. Since 2014, the SDMAs have used MPCSS as a venue for conducting state-wide emergency mock drills every year on June 19. The project trained approximately 28,340 taskforce members in AP and Odisha on search and rescue and first aid in partnership with Red Cross. The total 11-day training programs included a 1-day orientation about the MPCS and EWDS, a 4-day training on search and rescue, a 2-day training on first aid, 2 days on the use of equipment, and 2 days on record keeping. The project supplied a kit for every MPCS, consisting of a generator set; a telescoping light; solar lanterns; basic rescue equipment (for example, ladder, power saw, lifebuoy, life jacket, search light, and stretcher); kitchen utensils; a water filter and tank; a handheld megaphone; and a first aid kit. The taskforces were trained in the use of the MPCS kit and deployed during Cyclone Fani, contributing to timely evacuation, rescue, and first aid support to the communities. The taskforces paid special attention to vulnerable groups such as children, women, and PWD and arranged medicines for those in need. It should be noted that there was no quantitative target formally agreed at the time of appraisal and AF, but ISRs quantitatively measured the progress.</p>					

A.2 Intermediate Results Indicators

Component: B. Cyclone Risk Mitigation Infrastructure

Indicator Name	Unit of Measure	Baseline	Original Target	Formally Revised Target	Actual Achieved at Completion
Number of Cyclone Shelters	Number	0.00	297.00	532.00	535.00



completed under the project		22-Jun-2010	30-Apr-2015	31-Dec-2018	31-Dec-2018
<p>Comments (achievements against targets): The Project exceeded the revised target of 532 cyclone shelters by building 535 MPCs (219 in AP and 316 in Odisha). Based on land availability and village needs, the project built four types of MPCs with a design capacity varying from 325 to 970 persons per unit in AP while Odisha adopted two types of MPCs with an average design capacity of 1,000 people.</p>					

Indicator Name	Unit of Measure	Baseline	Original Target	Formally Revised Target	Actual Achieved at Completion
Roads constructed, Rural	Kilometers	0.00	1050.00	1310.00	1087.00
		22-Jun-2010	30-Apr-2015	31-Dec-2018	31-Dec-2018

Comments (achievements against targets):
While the project achieved 83% of targeted road length, the PIUs have constructed 12 additional bridges than the original estimate, effectively connecting some remote villages. As of April 2019, one bridge out of total 35 bridges was still under construction in AP with a physical progress of 84% due to re-designing required to take into account the potential barge impact. The PIU confirmed that the remaining works will be completed using the government fund by August 2019.

Indicator Name	Unit of Measure	Baseline	Original Target	Formally Revised Target	Actual Achieved at Completion
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Km of Embankments completed	Number	0.00	180.00	90.00	88.12
		22-Jun-2010	30-Apr-2015	31-Dec-2018	31-Dec-2018

Comments (achievements against targets):

The Project strengthened 88 km of embankments or 98% of the revised target (29.90km in AP and 58.22km in Odisha). The activity involved (i) upgrading the existing embankments by raising the top bund level to 5–6 m and widening the base in carefully selected high-risk areas, including construction of locking gates; (ii) strengthening or repairing the existing embankments, gap filling, and renovating sluices for improved drainage; (iii) slope protection from soil erosion such as vegetation and mangrove regeneration; and (iv) laying water-bound macadam on the top of the embankment with water-bound macadam for use as an access road by local communities. Although the project reduced the intermediate results indicator on embankments from 180 km to 90 km at the time of AF, the project adopted an improved design. The area of land and number of people to be protected by 180-km long embankments was not established at appraisal as detailed studies and final site selections had not been completed. Considering the increased height of embankments compared to the original design, land availability, and revised costing, the target length for Odisha (about 150km) was reduced by 60 percent while that for AP (about 30km) remained the same. At the time of AF, the project had disbursed 28 percent of original financing when procurement and construction of embankments had not taken place. As the actual unit cost of embankments increased by 109% compared to the estimated unit cost at appraisal, the project appropriately revised the target considering the available fund at the time of AF. It is of note that the unit of measurement in the results framework revised at the time of AF is expressed in percentage terms. ISRs reported the length of embankments instead of percentage.



Component: A. Early Warning Dissemination System and Capacity Building for Coastal Communities

Indicator Name	Unit of Measure	Baseline	Original Target	Formally Revised Target	Actual Achieved at Completion
Number of R-PACS installed (progressively in % terms) [target 3,400]	%	0% 22-Jun-2010	100% 30-Apr-2015	100% 31-Dec-2018	23% 31-Dec-2018

Comments (achievements against targets): The unit of measurement was the number of R-PACs at appraisal, but it was changed to % at the time of AF. The project adopted technology with higher population coverage during implementation. Therefore, the number of R-PACS installed is less than the original target, but the PDO indicator on population covered by EWDS met the target of 100%. It should be noted that this indicator was not captured in the Operations Portal and, therefore, ISRs did not report on this although this is included in the results framework. As the ICR datasheet is linked with the final ISR issued in January 2019, this indicator was manually created and inserted here.

Component: C. Technical Assistance for National and State Level Capacity Building and Knowledge Creation

Indicator Name	Unit of Measure	Baseline	Original Target	Formally Revised Target	Actual Achieved at Completion
% of targeted communities / people trained in use of early warning and evacuation	%	5% 22-Jun-2010	100% 30-Apr-2015	100% 31-Dec-2018	100% 31-Dec-2018

Comments (achievements against targets): The project targeted training of village-level emergency taskforces and MPCS committees from the local communities, and all of the 535 taskforces and 535 MPCS committees have received training. The baseline was established by the BME study in 2010. It should be noted that this indicator was not captured in the Operations Portal and, therefore, ISRs did not report on this although this is included in the results framework. As the ICR datasheet is linked with the final ISR issued in January 2019, this indicator was manually created and inserted here.

Indicator Name	Unit of Measure	Baseline	Original Target	Formally Revised	Actual Achieved at
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				Target	Completion
No. of government officials trained on specific disaster management skills	%	0.00	100%	100%	86%
		22-Jun-2010	30-Apr-2015	31-Dec-2018	31-Dec-2018

Comments (achievements against targets): This indicator measures the number of government officials trained by using the modules developed under the project. The project targeted 554 master trainers to be trained based on the capacity building strategy prepared by NIDM under the project. NIDM trained 475 master trainers (86%) under the project. It should be noted that this indicator was not captured in the Operations Portal and, therefore, ISRs did not report on this although this is included in the results framework. As the ICR datasheet is linked with the final ISR issued in January 2019, this indicator was manually created and inserted here.

Indicator Name	Unit of Measure	Baseline	Original Target	Formally Revised Target	Actual Achieved at Completion
Preparation of long-term training and capacity building strategy	N/A	N/A	Completed	Completed	Completed
		22-Jun-2010	30-Apr-2015	31-Dec-2018	31-Dec-2018

Comments (achievements against targets): A long-term training and capacity building strategy was prepared by the NIDM based on an institutional SWOT analysis and a survey of over 18,000 community members from across the six study states (Odisha, AP, Bihar, Gujarat, Uttarakhand, West Bengal). The NIDM developed a research agenda, human resource plans, accreditation process, national public awareness campaigns, and a road map for setting up centers of excellence. It should be noted that this indicator was not reported in ISRs. As the ICR datasheet is linked with the final ISR issued in January 2019, this indicator was manually created and inserted here.

Indicator Name	Unit of Measure	Baseline	Original Target	Formally Revised Target	Actual Achieved at Completion
All studies launched	N/A	N/A	N/A	Completed	Completed



		22-Jun-2010	30-Apr-2015	31-Dec-2018	31-Dec-2018
<p>Comments (achievements against targets): All studies required for developing a Composite Risk Atlas were launched. It should be noted that this indicator was not captured in the Operations Portal and, therefore, ISRs did not report on this although this is included in the results framework. As the ICR datasheet is linked with the final ISR issued in December 2018, this indicator was manually created and inserted here.</p>					
Indicator Name	Unit of Measure	Baseline	Original Target	Formally Revised Target	Actual Achieved at Completion
All studies completed	N/A	N/A	Completed		Completed
		22-Jun-2010	22-Jun-2010		31-Dec-2018
<p>Comments (achievements against targets): All studies required for developing a Composite Risk Atlas were completed, and the online Risk Atlas was completed. The atlas provides (i) the cyclone risk status associated to each state; (ii) historical cyclones; (iii) exposure distribution, risk, and loss details for residential, industrial, and commercial buildings; and (iv) population distribution details and the associated risk and loss with respect to cyclones. The atlas estimates economic exposures and population at risk using return periods of 5, 10, 25, 50, and 100 years based on historical data. It should be noted that this indicator was not reported in ISRs. As the ICR datasheet is linked with the final ISR issued in January 2019, this indicator was manually created and inserted here.</p>					

B. KEY OUTPUTS BY COMPONENT

Objective/Outcome 1. Coastal communities of Andhra Pradesh and Odisha covered by early warning and dissemination system (EWDS)	
Outcome Indicators	Proportion of the targeted coastal population covered by the EWDS [Target 100%]
Intermediate Results Indicators	Number of Remote Public Alert and Communication System (R-PACS) installed [Target 3,400]



Key Outputs by Component (linked to the achievement of the Objective/Outcome 1)	<ul style="list-style-type: none"> • Total 275 alert sirens installed in AP and Odisha including 413 towers and poles. • A location-based alert system integrated with a telecom service provider in Odisha.
Objective/Outcome 2. Coastal communities of Andhra Pradesh and Odisha having access to emergency shelter	
Outcome Indicators	<p>Proportion of people having access to emergency shelters in Odisha [Target 80%]</p> <p>Proportion of people having access to emergency shelters in Andhra Pradesh [Target 88%]</p>
Intermediate Results Indicators	<p>Number of MPCS completed under the project [Target 532]</p> <p>Kilometer of roads completed [Target 1,310km]</p>
Key Outputs by Component (linked to the achievement of the Objective/Outcome 2)	<ul style="list-style-type: none"> • Total 535 MPCS constructed (219 in AP and 316 in Odisha) • Total 1,087 km of roads constructed (698 km in AP and 389 km in Odisha) • 34 bridges constructed in AP. One more bridge is expected to be completed in August 2019; the remaining contract value will be paid by the government.
Objective/Outcome 3. Coastal communities protected by strengthened or improved embankments	
Outcome Indicators	Land protected by strengthened/improved embankments [Target 30,000 ha]
Intermediate Results Indicators	Kilometer of embankment completed [Target 90 km]
Key Outputs by Component (linked to the achievement of the Objective/Outcome 3)	<ul style="list-style-type: none"> • Total 88.12 km of embankment strengthened/improved in AP and Odisha, protecting total 29,537 ha. • The existing embankments (total 29.9 km) were strengthened in AP, protecting 12,800 ha of agricultural land. • The existing embankments (total 58.22 km) were strengthened in Odisha, protecting 16,737 ha of agricultural land.
Objective/Outcome 4. Increased awareness about warnings and emergency response among targeted coastal communities	
Outcome Indicators	Increased awareness about warnings and emergency response



Intermediate Results Indicators	Percentage of targeted communities/people trained in use of early warning and evacuation
Key Outputs by Component (linked to the achievement of the Objective/Outcome 4)	<ul style="list-style-type: none"> • Total 28,340 people from the targeted coastal communities of AP (12,542 people) and Odisha (15,800 people) trained in early warnings, evacuation, disaster management skills, first aid, and S&R and participated. • Total 535 village-level disaster management taskforces established in AP (219 taskforces) and Odisha (316 taskforces). • Total 535 villages in the coastal districts of AP and Odisha conducted annual emergency mock drills since 2014.
Objective/Outcome 5. Institutional strengthening	
Outcome Indicators	Increased awareness about disaster risk management
Intermediate Results Indicators	<ol style="list-style-type: none"> 1. No. of government officials trained on specific disaster management skills 2. Preparation of long-term training and capacity-building strategy 3. All studies launched 4. All studies completed
Key Outputs by Component (linked to the achievement of the Objective/Outcome 5)	<ul style="list-style-type: none"> • A web-based composite Composite Risk Atlas developed and accessible by all the coastal states. • The PDNA tools comprised of a handbook, manual, and standard operating procedures developed. • A long-term training and capacity building strategy prepared by the NIDM based on an institutional SWOT analysis and a survey of over 18,000 community members from across the six study states (Odisha, AP, Bihar, Gujarat, Uttarakhand, West Bengal). • 7 multi-hazard training modules prepared by the NIDM with a focus on mainstreaming disaster risk reduction and climate change adaptation in (i) Panchayat Raj Institutions, (ii) rural development, (iii) ULBs, (iv) city planning, and (v) education as well as disaster management planning for (i) hospitals and (ii) cities. • 16 ToT programs implemented by the NIDM using the training modules. • 475 master trainers from relevant government institutions trained.

**ANNEX 2. BANK LENDING AND IMPLEMENTATION SUPPORT/SUPERVISION****A. TASK TEAM MEMBERS**

Name	Role
Preparation	
Supervision/ICR	
Deepak Singh	Task Team Leader(s)
Geeta Shivdasani, Jurminla Jurminla	Procurement Specialist(s)
Supriti Dua	Financial Management Specialist
Vidya Mahesh	Team Member
Venkata Rao Bayana	Social Specialist
Neha Pravash Kumar Mishra	Environmental Specialist
Peeyush Ramawtar Sekhsaria	Team Member
Keisuke Iyadomi	Team Member
Deepak Malik	Team Member
Anup Karanth	Team Member
Hyunjee Oh	Team Member

B. STAFF TIME AND COST

Stage of Project Cycle	Staff Time and Cost	
	No. of staff weeks	US\$ (including travel and consultant costs)
Preparation		
FY05	22.247	129,754.10
FY06	10.264	66,896.95
FY07	5.068	26,668.70
FY08	8.136	44,316.60
FY09	29.199	95,705.54



FY10	39.324	143,966.15
FY11	0	284.99
Total	114.24	507,593.03
Supervision/ICR		
FY11	23.660	63,420.44
FY12	46.843	155,220.39
FY13	59.408	238,488.46
FY14	27.479	179,862.32
FY15	37.209	279,876.45
FY16	11.776	86,402.85
FY17	16.496	91,613.48
FY18	19.072	151,592.12
FY19	26.889	163,354.59
FY20	.400	93.34
Total	269.23	1,409,924.44



ANNEX 3. PROJECT COST BY COMPONENT

Components	Total Commitment Amount at Appraisal (US\$, millions)	Total Commitment Amount at AF (US\$, millions)	Actual at Project Closing (US\$, millions)	Percentage of Approval (%)
A. EWDS and Capacity Building for Coastal Communities	15.00	15.00	16.45	110
B. Cyclone Risk Mitigation Infrastructure (75% World Bank Financing; 25% Counterpart Financing)	250.00	378.00	331.29	88
C. Technical Assistance for National and State Level Capacity Building and Knowledge Creation	6.00	6.00	3.07	51
D. Project Management and Implementation Support	20.70	28.70	18.27	64
Total	291.70	427.70	369.08	86

Note: Amount at approval and actual at project closing comprise the original financing, AF, and counterpart funds as of May 31, 2019. There was an unallocated contingency of US\$27.3 million. As the information on component-wise expenditure was only available in Indian rupees, the average exchange rate of INR 64.96 per USD was applied to estimate the actual cost at project closing due to currency fluctuations throughout implementation.



ANNEX 4. EFFICIENCY ANALYSIS

Part I - Background

1. Global natural disaster losses have risen dramatically in recent decades and tropical cyclones have contributed significantly to this trend. Tropical cyclones account for nine of the ten most costly inflation-adjusted insurance natural disaster losses between 1970 and 2009.⁷² Tropical cyclones account for two of the five most costly economic losses and four of the five most costly insurance losses from natural disasters from 1950 to 2009.⁷³ The significant increase in losses has also made the question of how to better manage tropical cyclones, and natural hazards more generally, even more salient.

2. The seventh International Workshop on Tropical Cyclones reiterated the significance and social impact of DRM investments in cyclone risk mitigation, which can be captured in these statements from the workshop:⁷⁴

- For every US\$1 invested, a return of US\$40.85 in benefits over a 10-year period may be realized.
- For every US\$1 investment, a return of US\$70 in benefits in the Pacific cyclone early warning system in the case of Samoa.

3. Furthermore, the World Bank⁷⁵ calculates that hydrometeorological information and early warning systems across Europe generate BCRs from 4 to 36. Although the proposed analytical framework does not deal directly with mitigation infrastructure, the structure of the model has intrinsic and practical value for the case of the project as well.

4. **Economic damage and spillovers from a tropical cyclone.**⁷⁶ Tropical cyclones cause widespread damage in specific regions because of high winds and flooding. Direct impacts on commercial property and infrastructure can lead to reduced growth in the economy. Therefore, powerful tropical cyclones have the ability to cause severe disruptions in the local economy that are felt far beyond the areas of landfall and flooding.

5. **Vulnerability profiles of AP and Odisha.** The coastline of AP and Odisha is 974 km and 476 km, respectively, with the total state population of 53 million and 43 million, respectively. Approximately 1 million residents in AP and 4 million in Odisha are at risk of cyclone with a 50-year return period while 2.3 million in AP and 5.6 million in Odisha are at risk of a 100-year cyclone.⁷⁷ The annual exceedance

⁷² Swiss Reinsurance Company. 2010. "Natural Catastrophes and Man-made Disasters in 2009: Catastrophes Claim Fewer Victims, Insured Losses Fall." *Sigma No 1/2010*.

⁷³ Munich Re Group. 2010. "Natural Catastrophes 2009. Analyses, Assessments, Positions." TOPICS GEO.

⁷⁴ https://www.wmo.int/pages/prog/arep/wwrp/tmr/documents/T6.1_ppt.pdf.

⁷⁵ Hallegatte, Stéphane. 2012. "A Cost Effective Solution to Reduce Disaster Losses in Developing Countries Hydro-Meteorological Services, Early Warning, and Evacuation". Policy Research Working Paper WPS6058.

⁷⁶ Lenzen, M., et al. 2019. "Economic Damage and Spillovers from a Tropical Cyclone." *Natural Hazards and Earth System Sciences* 19: 137–151.

⁷⁷ According to the Composite Risk Atlas developed by the project.



probability of an Extremely Severe Cyclonic Storm is estimated at 6 percent to 9 percent based on the Composite Risk Atlas developed by the project (Component C), and the frequency and severity of the cyclones may increase due to climate change.

6. **Macroeconomic impact of cyclones on local economies.** AP has maintained a very high level of growth in the gross state domestic product (GSDP) for a number of years and the latest annual rate of GSDP growth is estimated at 11.22 percent, which is one of the highest in the country.⁷⁸ The reconstruction cost of Cyclone Hudhud was estimated at US\$2.16 billion.⁷⁹ In Odisha, growth was curtailed due to Cyclone Phailin of 2013 followed by Cyclone Hudhud of 2014.⁸⁰ Cyclone Phailin had very adverse impact on coastal districts and caused extensive damage on property, which was followed by torrential rains and heavy floods in all affected districts. This further aggravated the sufferings of the people and caused damage to crops and infrastructure. The agricultural sector grew robustly at a rate of 12.3 percent during FY12–13. However, this was followed by a negative growth rate in FY13–14 mainly caused by Cyclone Phailin and flash floods in the state in October 2013. As a consequence, the agriculture and animal husbandry sector only grew by some 2 percent during FY14–15.

7. **Economic analysis at appraisal.** The project was expected to bring significant economic benefits to the local communities in cyclone-affected areas by reducing potential damages to physical, environment, and human capital in the event of cyclones and protecting the local economies from downturns because of disaster impacts. To estimate the benefits, the economic analysis attempted to establish the cyclone hazard intensity and frequency discharge relationship in selected local districts, then build the vulnerability function, and finally estimate the cost and benefit under scenarios of with and without project to calculate the ERR. Two districts were selected to inform the ERR estimation process. These were Kendrapara in Odisha and Vishakhapatnam in AP. The Odisha and AP cases reflected technical features of the cyclone and vulnerability function on the east coast along the Bay of Bengal.

8. The ERR and the BCRs were reported to show significant positive results for all the embankments and cyclone shelter components. It was indicated that the sensitivity analysis confirmed the robustness of the ERR by testing the scenarios in which benefit or cost variables were allowed to vary by 20 percent. The results showed that the embankment and shelter components could achieve an ERR of about 30 percent, with positive BCR. It was argued that the embankment investment was more efficient in reducing the damage from storm surge, which caused the greatest capital loss during a cyclone. The analysis used a VSL estimate of US\$150,000.⁸¹ The results showed that Odisha had a high ERR in cyclone shelter component (73 percent), followed by AP (28 percent).

9. **Economic analysis at AF.** The analysis was premised on the hypothesis that the principal benefit of the overall risk mitigation investment would consist of the avoided damage cost as a result of project interventions. This was measured by the difference in the damage cost that is directly related to disasters between the baseline scenario (damage cost from a natural disaster without any risk mitigation investment) and a future scenario with the project and a natural disaster occurrence, everything else being the same. It was unclear whether the existing mitigation infrastructure was considered and the

⁷⁸ Andhra Pradesh Socio Economic Survey, 2017–2018.

⁷⁹ GoAP, World Bank, and ADB 2014.

⁸⁰ Odisha Economic Survey, 2014–2015.

⁸¹ Cropper, Maureen L., S. Bhattacharya, and A. Alberini. 2007. "The Value of Mortality Risk Reduction in Delhi, India." *Journal of Risk and Uncertainty*, 34:21-47.



project benefits accounted for in an incremental manner. The damage assessment from Cyclone Phailin of 2013 was used as the baseline estimate, which is not explicitly shown in the calculations.

10. It was reported that the damage cost included both the direct and indirect costs. The direct cost was the valuation of physical assets and human capital that had been damaged or destroyed by the disasters in the absence of risk mitigation. The indirect cost included loss of production output due to power failure or transportation destruction, loss of agriculture production due to soil salinity contamination because of storm surges, and the indirect health impact on the population. The health impacts, although difficult to quantify, were often more important than the output losses in the event of a natural disaster.

11. The focus of the economic analysis was on the two components selected for the AF: MPCS and roads and bridges. The AF focused on providing greater protection to vulnerable populations and livestock in the cyclone prone areas by constructing new multipurpose shelters, improving existing shelters, and making roads to enable communities to access safe shelters during cyclones. As demonstrated in the recent Cyclone Phailin, cyclone shelters have proved extremely helpful in saving thousands of human lives and livestock while the construction and restoration of roads and bridges improved connectivity and thereby gave impetus to emergency operations and economic activity impacted by destruction from cyclone. While the construction of cyclone shelters would be mainly new construction, that of roads and bridges was based on improving existing infrastructure implying lower investment costs.

12. The life-span of these infrastructures was assumed to be 20 years. Under this assumption, the BCR for cyclone shelters at 5 percent discount rate was 6.4 and at 10 percent discount rate it was 3.9. For restoration of roads and bridges, it was 15.6 using a 5 percent discount rate and 12.4 using 10 percent. It was concluded that these results were deemed consistent with the economic analysis undertaken at appraisal, although there was quite a significant departure from the analysis.

13. **Comments on the CBA for the Original Financing and AF.** The EFAs supporting both the original project and AF do not seem to be making a strong case for the project. The original EFA operation is a partial one based on case studies on two districts and did not fully cover the full project scope while that of the AF does not seem to adequately substantiate its claims. Both EFAs are component based and the analysis was performed in a selective manner. Neither analysis makes reference to the vulnerable population in terms of number of persons and does not report on the hazard probability.

Part II: Reestimation of the Project Efficiency Parameters

14. Given the above background and discussion, the project's economic efficiency parameters (ERR, BCR, and NPV) have been reestimated by two separate ERR models using a retroactive analysis. The reestimated ERR is based upon an approach which involves the EWDS, roads, and the MPCS being a single set of investments and facilities whereby people are warned about an upcoming cyclone and then to move to safety (that is, to the MPCS). This aspect is being evaluated as an analytical set labeled as Block 1 and quantified in terms of lives saved. Embankments are being viewed separately, mainly by saving land from salination or submergence and thus preserving livelihoods. This aspect constitutes Block 2 analysis.



Table 4.1. EFA Methodology

Analytical Block	Investment Content	Investment Cost (US\$ million)	Benefits Considered in the Reestimated CBA	Other Economic Benefits Not Considered in the Reestimated CBA ^a
Block 1	EWDS (Component A); MPCS, roads, and bridges (Component B); and Implementation support (Component D)	330	<ul style="list-style-type: none"> Lives saved 	<ul style="list-style-type: none"> Unlocked economic potential Co-benefits Benefits associated with multipurpose use of facilities and infrastructure Savings in Public Investment Program (offset investments)
Block 2	Saline embankments (Component B)	40	<ul style="list-style-type: none"> Crop and property losses avoided, Soil salinity avoided 	<ul style="list-style-type: none"> Lives saved
Total		370		

Note: a. Lives saved, unlocking economic potential and co-benefits are discussed in the World Bank’s Triple Dividends of Resilience, https://www.gfdrr.org/sites/default/files/publication/The_Triple_Dividend_of_Resilience.pdf.

15. **Assumptions and parameters for Block 1.** The reestimation process employs the following list of parameters and assumptions which are shown in table 4.2 and discussed in the following paragraphs .

Table 4.2. Data and Parameters for CBA - Block 1

Description	Units	Base Case Levels	
		Without Project	With Project
Cyclone hazard	IMD classification	Extremely Severe Cyclonic Storm and Higher	
Investment (all components except embankments)	US\$ million	0	340
Estimated number of direct beneficiaries	Person	443,425	
Mortality rate ^(a)	Percent	2	0
VSL	US\$	275,000	
Annual exceedance probability	Percent	7	
Planning horizon	Years	n.a.	20
Discount rate	Percent	n.a.	6
Discount rate for sensitivity	Percent	n.a.	10

Note: (a) A study conducted in 2015 revealed that due to shortage of cyclone shelter capacity in AP, some 2113 casualties would occur in the event of a disaster. This corresponded to an era when the shelter capacity shortfall was estimated roughly at 100,000 by the author. http://imetsociety.org/wp-content/pdf/vayumandal/2015/2015_6.pdf.

16. **Investment.** The current value of the combined original project and AF investment packages amount to US\$370 million, of which US\$320 million (including government contributions) is associated



with Block 1 investments. An attempt was made to re-estimate the ERR in a retroactive manner whereby project benefits were assumed to accrue gradually as investments were being completed.

17. **Number of direct beneficiaries.** The number of beneficiaries has been calculated using the design capacity of the MPCs. As the project built a total of 535 MPCs in AP and Odisha, the total design capacity is estimated at 443,425 people. This is considered conservative as the maximum peak occupancy could be higher than the design capacity of average 6 sq. ft. per person during emergency.

18. **Mortality rate.** Counterfactual mortality is estimated at 2 percent of the sheltering capacity created by the project. In plain language, this means that if the shelters were never to be built, people would find alternative shelter, but 2 percent would lose their lives in the process.

19. **VSL.** To arrive at the right choice when prevention saves lives, an attempt is often made to associate some numerical estimate to the value of life.⁸² The relevant concept is the VSL, which has found widespread application in recent times. VSL estimates come from willingness-to-pay surveys and reflect, to a much higher degree, the intrinsic value of life. As cyclone risk insurance is uncommon in India, human life related valuation data in the insurance practice was unavailable. Therefore, due to paucity of contextualized and reliable VSL estimates applicable for India, the ‘benefits transfer’ method is an appropriate tool to value the lives potentially saved by the project.⁸³ By transferring a base VSL from the United States calculated using labor market estimates, coupled with adjustments for differences in income between the United States and India, a study estimates a VSL for India at US\$275,000 based on the World Bank’s GNI per capita data using the Atlas method.⁸⁴ Another study shows that a VSL for India could be as high as US\$1 million using the GNI per capita data based on PPP method.⁸⁵ This analysis adopts the US\$275,000 VSL based on the Atlas method, which is relatively consistent with the VSL used at appraisal (US\$150,000).

20. **Annual exceedance probability.** Using the Composite Risk Atlas developed under the project and the Weibull estimation technique, the exceedance probability for an Extremely Severe Cyclonic Storm has been calculated and is estimated at 7 percent. This means that in any given year there is at least a 7 percent chance (it may go as high as 10 percent) that either AP or Odisha will be hit by a major cyclonic event, corresponding to an implied return period of some 14 years.

21. **Results and discussion on Block 1.** The worksheet capturing the interplay between the above described parameters and assumptions is shown in table 4.3, where the project ERR, BCR, and NPV are calculated. The conclusion from the analysis is that the BCR is close to 5, with the ERR being 53 percent.

⁸² Natural Hazards Unnatural Disasters, https://www.gfdrr.org/sites/gfdrr/files/publication/NHUD-Report_Full.pdf.

⁸³ Cropper, Maureen L., and Sebnem Sahin. 2009. “Valuing Mortality and Morbidity in the Context of Disaster Risks (English).” Policy Research Working Paper WPS 4832, World Bank, Washington, DC.

⁸⁴ Viscusi, W. K., and C. Masterman. 2017. “Income Elasticities and Global Values of a Statistical Life.” *Journal of Benefit Cost Analysis* 8 (2): 226–250.

⁸⁵ Viscusi, W. K., and C. Masterman. 2017. “Income Elasticities and Global Values of a Statistical Life.” *Vanderbilt Law Research Paper No. 17-29*.



Table 4.3. Base Case Scenario for Block 1

Project Years	W/O Project	W/ Project	Increments and Calculations				Project Costs	Cash Flow
	Number of Casualties	Number of Casualties	VSL	Avoided Loss of Life	Hazard Excd. Probability	Probability Weighted Benefits		
	person	person	US\$	US\$ million	percent	US\$ million		
1	8,869	8,869	275,000	-	7%	-	17	(17)
2	8,869	8,869	275,000	-	7%	-	50	(50)
3	8,869	7,095	275,000	488	7%	34.14	50	(15)
4	8,869	5,321	275,000	976	7%	68.29	50	19
5	8,869	3,547	275,000	1,463	7%	102.43	50	53
6	8,869	2,661	275,000	1,707	7%	119.50	50	70
7	8,869	709	275,000	2,244	7%	157.06	50	108
8	8,869	355	275,000	2,341	7%	163.89	17	147
9	8,869	0	275,000	2,439	7%	170.72		171
10	8,869	0	275,000	2,439	7%	170.72		171
11	8,869	0	275,000	2,439	7%	170.72		171
12	8,869	0	275,000	2,439	7%	170.72		171
13	8,869	0	275,000	2,439	7%	170.72		171
14	8,869	0	275,000	2,439	7%	170.72		171
15	8,869	0	275,000	2,439	7%	170.72		171
16	8,869	0	275,000	2,439	7%	170.72		171
17	8,869	0	275,000	2,439	7%	170.72		171
18	8,869	0	275,000	2,439	7%	170.72		171
19	8,869	0	275,000	2,439	7%	170.72		171
20	8,869	0	275,000	2,439	7%	170.72		171
Net Present Values						1,349	256	

IRR	53%
NPV	1,093
B/C	5.28

Note: As observed during the Cyclone Fani of 2019, the number of casualties may not go down to zero. However, the analysis assumed 'zero casualty' as envisaged by the GoI for the sake of analysis.

22. **Comparison with the initial design.** An effort was made to compare the CBA results from the Block 1 analysis with results at appraisal and AF. The highest ERR was 73 percent and the lowest was 15 percent, both of which were reported in the PAD. Both the IRR, BCR, and ERR seem to lie within the confines defined by the design efficiency parameters.

Table 4.4. Comparison of Block-1 EFA at Appraisal, AF and Completion

Description	PAD	AF	Post Project	
			6%	10%
Discount rate	10%	5%	6%	10%
NPV (US\$ million)	N/A	N/A	1,093	684
Benefit cost ratio (BCR)	1.2 to 4	6.4 to 15.6	5.28	4.13
ERR (%)	15% to 73%	N/A	36%	



23. **Sensitivity analysis on Block 1.** A sensitivity analysis was performed for the above base case scenario by parametrically varying key variables consisting of the VSL and number of lives saved. The results obtained are shown in table 4.5, which highlights that the project can break even (that is, attain 6 percent discount rate level) when the VSL is as low as US\$73,000 and the number of lives saved as low as 1,700. A discount rate of 10 percent lowers the BCR from 5.3 to approximately 4.

Table 4.5. Sensitivity Analysis Results for Block 1

Scenarios Studied	VSL	Lives Saved	OCC	Hazard Probability	Horizon	IRR	NPV	BCR
	US\$	person	percent	percent	years	percent	US\$ m	N/A
Base Case	275,000	8,869	6%	7%	20	53%	1,093	5.28
Breakeven VSL	72,880	8,869	6%	7%	20	12%	102	1
Breakeven Lives Saved	275,000	1,678	6%	7%	20	6%	0	1
Discount Rate - 10%	275,000	8,869	6%	7%	20	53%	684	4.13

24. **Assumptions and parameters for Block 2.** The reestimation process employs the following parameters and assumptions (see table 4.6) and is briefly discussed below.

Table 4.6. Data and Parameters for CBA - Block 2

Description	Units	Base Case Levels	
		Without Project	With Project
Embankment investment	US\$, millions	0	40.00
Annual benefits at full development	US\$, millions	0	5.25
Assumed BCR	Dimensionless	n.a.	1.50
Planning horizon	Years	n.a.	20.00
Discount rate	Percent	n.a.	6.00
Discount rate for sensitivity	Percent	n.a.	10.00
Simulation on design parameters			
Annual benefits at full development	US\$, millions	0	7.10
Assumed BCR	Dimensionless	n.a.	2.00

25. The main benefits of saline embankments consist of (i) protection of agriculture lands from saline water intrusion, storm surge, and inundation; (ii) protection of habitation from surge and inundation; and (iii) connectivity to main roads and evacuation routes.

26. The saline embankment activity was about US\$54.5 million at appraisal, and estimated expenditures amounted to US\$40 million at project completion. Detailed economic analyses were unavailable. The original project had a PDO indicator measuring the number of people and the area of land protected. The intermediate results indicator tracked the number of kilometers of embankments completed. The PDO indicator on the number of people benefiting from embankments was dropped at restructuring, while the project only collected data on the area of land protected (29,525 ha at completion) and the length of the embankments upgraded and repaired (91.12 km at completion).



27. Benefit-related information was lacking and was derived by means of backward calculations based upon a conservative BCR of 1.5 which was matched by an annual benefit stream US\$5.25 million for the entire package of US\$40 million in embankment improvement investments by the project.

28. **Results and discussion on Block 2.** The retroactive ERR model is shown in table 4.7 for the base case, where the ERR, BCR, and NPV have been calculated. The ERR for the base case is estimated at 13 percent. When the Block 1 and Block 2 analyses are combined, the consolidated ERR for the entire project assumes a value of 48 percent.

Table 4.7. Base Case Scenario for Block 2

Project Year	Investment Cost	Benefits Accrued	Cash Flow Block 2	Cash Flow Block 1	Consolidated Project Cash Flow
				US\$ million	US\$ million
1	8.00	1.05	-6.95	-16.50	-23.45
2	8.00	2.10	-5.90	-49.50	-55.40
3	8.00	3.15	-4.85	-15.36	-20.21
4	8.00	4.20	-3.80	18.79	14.99
5	8.00	5.25	-2.75	52.93	50.18
6	0.00	5.25	5.25	70.00	75.25
7	0.00	5.25	5.25	107.56	112.81
8	0.00	5.25	5.25	147.39	152.64
9	0.00	5.25	5.25	170.72	175.97
10	0.00	5.25	5.25	170.72	175.97
11	0.00	5.25	5.25	170.72	175.97
12	0.00	5.25	5.25	170.72	175.97
13	0.00	5.25	5.25	170.72	175.97
14	0.00	5.25	5.25	170.72	175.97
15	0.00	5.25	5.25	170.72	175.97
16	0.00	5.25	5.25	170.72	175.97
17	0.00	5.25	5.25	170.72	175.97
18	0.00	5.25	5.25	170.72	175.97
19	0.00	5.25	5.25	170.72	175.97
20	0.00	5.25	5.25	170.72	175.97
NPV	33.70	50.86	17.16		

IRR	13%
NPV	17.16
BCR	1.51

IRR	48%
NPV	1,110

29. **Sensitivity analysis on Block 2.** When the assumed BCR is raised to 2, the ERR estimate increases to 20 percent with an accompanying benefit stream of US\$7 million per year. In contrast, an annual benefit stream of US\$3.5 million earns an ERR of 6 percent, which corresponds to the breakeven level.



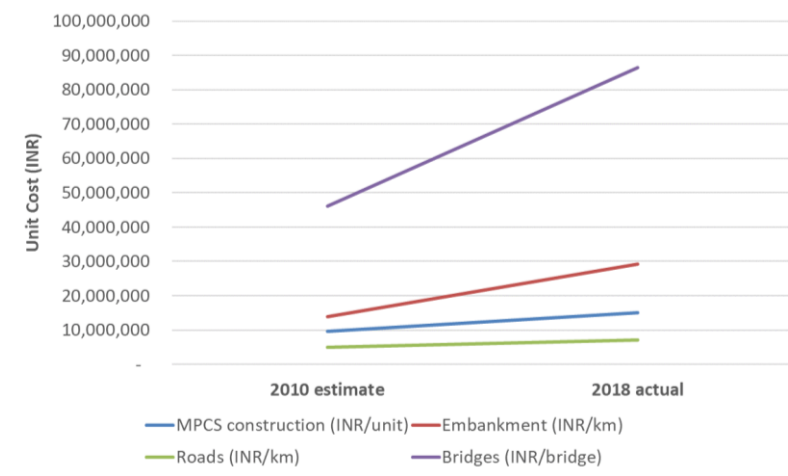
Table 4.8. Sensitivity Analysis Results for Block 2

Scenarios Studied	Annual Benefits @ Full Devt.	OCC	Horizon	IRR	NPV	BCR
	US\$ million	percent	years	percent	US\$ million	N/A
Base Case BCR = 1.5	5.25	6%	20	13%	17.2	1.5
Breakeven	3.50	6%	20	6%	0.2	1.0
BCR = 2	7.10	6%	20	20%	33.9	2.0
Discount Rate = 10%	5.25	10%	20	13%	5.7	1.2

Part III - Efficiency as Related to Design and Implementation

30. **The extended project timeframe of almost eight years, improvement in designs, and other factors increased the unit costs.** At project closing, the actual unit costs of MPCSSs, roads, bridges, and embankments in Indian rupees (INR) increased by 59 percent, 47 percent, 87 percent, and 109 percent, respectively, compared to the estimates at appraisal (figure 4.1).⁸⁶ Despite the increased unit costs, the improved designs provided enhanced benefits to the coastal communities. For example, the increased height of embankment provided greater protection of agricultural land from storm surges. The MPCS designs were improved to incorporate lessons learned from the Cyclones Phailin and Hudhud, securing greater structural integrity and safety of evacuees. Also, the decision to install a lightning arrester at every MPCS was made during implementation, providing protection of local communities from an increasing number of lightning incidents observed across India. In addition, the following factors contributed to the increased unit costs: (i) remoteness of the project sites and small civil contracts adversely affected the market appetite and resulted in less competition and high bid prices, (ii) increased cost of labor and materials over time, and (iii) difficulty in sourcing materials near the project sites.

Figure 4.1. Estimated and Actual Unit Costs of MPCS, Roads, Bridges and Embankments



Source: The 2010 estimates based on PAD (World Bank, 2010); the 2018 actual costs based on Final IUFRR (NDMA 2019a; NDMA 2019b)

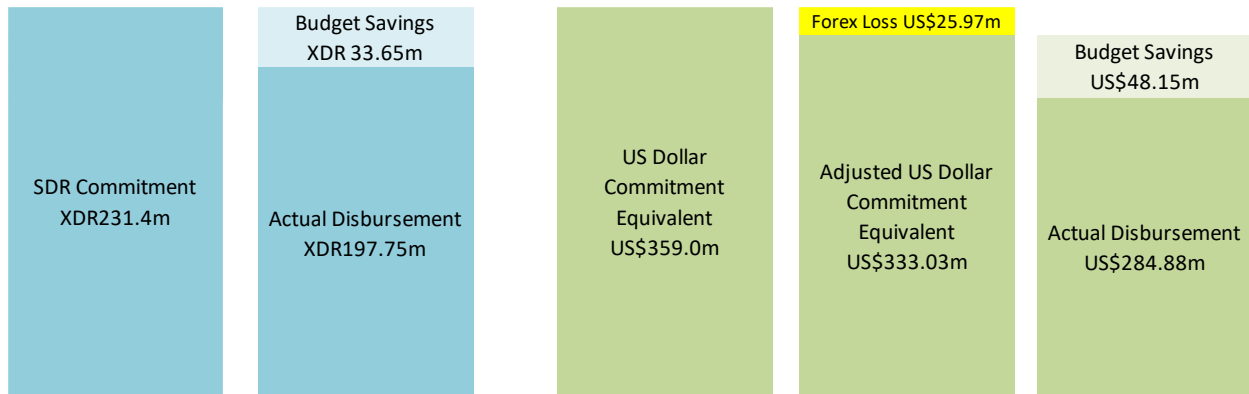
⁸⁶ The original project costs were available in U.S. dollars only. The exchange rate at the time of appraisal (INR 46.17 per US\$) was used for the analysis.



31. **The actual INR cost of Component A was higher than the original estimate by 54 percent while the actual INR costs of Components C and D were reduced by 28 percent and 18 percent, respectively.** The actual cost of Component A increased at project closing because of the changes in technological options adopted and the requirements for installing voltage stabilizers and other associated equipment during implementation. Although the project trained 86 percent of the targeted government officials, it efficiently delivered the planned outputs of Component C. Although project implementation experienced delay, the project management cost (Component D) was only 5 percent of the total actual project cost, implying administrative efficiency in achieving the outcomes. The current value of budget saving in Components C and D is estimated at US\$5.27 million.

32. **The Project disbursed 85.5% of financing in SDR and undisbursed fund of SDR33.65 million was cancelled following the end of the grace period on May 31, 2019.** As per the FA, the PMU made applications in INR terms and the Bank made reimbursements in USD terms using the exchange rate at the time of application. The PMU and PIUs spent approximately 104 percent of the total commitment estimated in INR at the time of appraisal and AF⁸⁷ due to the exchange rate fluctuation in INR to USD.⁸⁸ Except for the internationally procured alert sirens, all the goods and works were procured by national competitive bidding. Although the unit costs increased in local currency, the INR depreciated enough that there were savings of SDR33.65 million (US\$48.15 million equivalent). Although cancellation of US\$20 million equivalent was considered at the time of MTR in May 2013 due to savings from optimization of designs and currency fluctuations, it was not done as 90 percent of financing was committed by AF approval. It should be noted that due to exchange rate fluctuations between SDR and USD, the value of the IDA Credits expressed in USD terms decreased from US\$359 million to US\$333 million compared to the value at the time of approval (figure 4.2).

Figure 4.2. Analysis of Project Commitments and Disbursement in USD and SDR



Source: Client Connection financial data (Accessed on June 25, 2019).

33. **It should be noted that the PMU and PIUs spent approximately 104% of the total commitment estimated in INR at the time of appraisal and AF⁸⁹ due to the exchange rate fluctuation in INR to USD**

⁸⁷ INR46.17/USD and INR61.98/USD respectively.

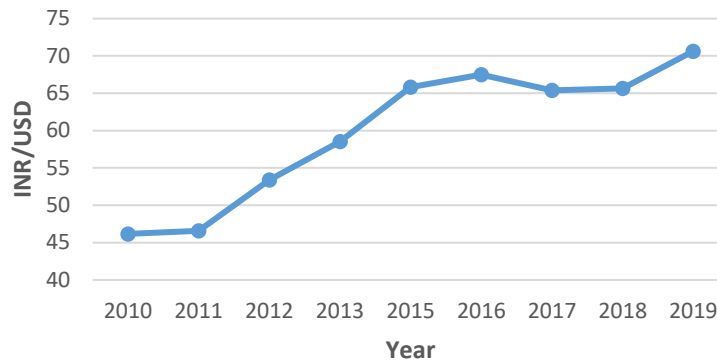
⁸⁸ It is of note that the PMU used a different exchange rate (INR52.45/USD) for the purpose of financial monitoring (94 percent disbursement).

⁸⁹ INR46.17/USD and INR61.98/USD respectively.



(see figure 4.3). The PMU used a different exchange rate (INR52.45/USD) for the purpose of financial monitoring (94% disbursement).

Figure 4.3. Historical Exchange Rates of INR and USD



Source: The 2010 rate based on PAD (World Bank, 2010); the 2011-2013 rates based on the U.S. Federal Reserve; the 2014 rate based on the AF Project Paper (World Bank, 2014); the 2015-2019 rates based on the Client Connection disbursement data (Accessed on June 27, 2019).

34. **An extension of 3.7 years was required to achieve the outcomes, affecting efficiency.** The project achieved original intermediate results indicator on MPCs 1.5 years after the original closing date⁹⁰ and on roads and embankments three years after the original closing date.⁹¹ The installation of EWDS in AP was completed after the closing date. As discussed in section III.B, procurement, land availability, environmental clearances, delays in obtaining a cabinet clearance for the original project and AF (total 23 months), and other factors affected implementation. Bifurcation of the state into Andhra Pradesh and Telangana under the Andhra Pradesh Reorganization Act of 2014 and the transition significantly slowed implementation and procurement of civil works in AP. Several natural hazards including the Extremely Severe Cyclonic Storm Phailin of 2013, Very Severe Cyclonic Storm Hudhud of 2014, Very Severe Cyclonic Storm Titli of 2018, and Cyclonic Storm Phethai of 2018 also adversely affected the implementation.

35. **The project implementation arrangements remained stable throughout implementation and were adopted in the subsequent Bank-funded NCRMP-II (P144726),** which adopts the project’s community-based asset management mechanism and monitoring and evaluation arrangements, and partners with the same TPQA for installing EWDS in six coastal states. In addition, despite the extended project timeframe, the task team leader turnover was low (twice), and team members who had been involved in the project since preparation subsequently took over the leadership role.

36. **The scaled-up outcome is considered to be reasonably commensurate with the AF.** The AF scaled up the construction of roads and MPCs, providing additional access to about 206,150 coastal residents and increasing the original outcome by 87 percent. While the AF was initially provided to increase the financing for MPCs and roads by 88 percent, the actual expenditure was 109 percent higher than the

⁹⁰ NDMA. 2016. NCRMP-I PSC Meeting held on December 28, 2016 - Minutes of the Meeting.

⁹¹ NDMA. 2018. NCRMP-I 18th PSC Meeting held on August 17, 2018 - Minutes of the Meeting.



appraisal estimate due to the increased unit costs (figure 4.4). Therefore, it is considered that the additional outcome was reasonably commensurate with the AF.

Figure 4.4. Original and Actual Financing and Outcome on MPCS Accessibility



Source: Financing data based on PAD (World Bank 2010) and AF Project Paper (World Bank 2014); outcome data from GoAP 2019 and GoO 2019.



ANNEX 5. BORROWER, CO-FINANCIER AND OTHER PARTNER/STAKEHOLDER COMMENTS

The NDMA, APSDMA, and OSDMA provided comments to this ICR, which were incorporated in the final version of the report. Comments are summarized below.

Comments from the NDMA (received on August 21, 2019): The draft Implementation Completion & Results Report (ICR) for NCRMP (Phase I) shared by the World Bank has been thoroughly reviewed. The ICR is well-written based on comprehensive assessment of implementation capturing component-wise targets and achievement status of the project. Few relevant comments to be incorporated in the report are as follows:

- *Page 6 (Section 5- Theory of Change; Point 5):* PDNA study was completed in January 2017 by NIDM in association with ADPC and PDNA Tools for India were developed under the study. NIDM is planning to organise a National Workshop on PDNA study and afterwards PDNA Tools for India, incorporating comments/feedback from States, will be rolled out for adoption by States/UTs.
- *Page 11 (Section B- Achievement of PDOs; Point 22):* Total 413 Towers & Poles [221 Towers (AP- 118 & Odisha- 103) and 192 Poles (5 meter) [AP-135 & Odish-57) are erected for mounting Alert Sirens under NCRMP (Phase I).
- *Page 14 (Section B- Achievement of PDOs; Point 31):* Corpus fund @ 5 Lacs each for CSMMCs registered under Society Act is fully financed by State Governments.
- *Page 15 (Section B- Achievement of PDOs; Point 33):* The project strengthened 29.90 Km existing Saline Embankments in AP and 58.22 Km existing Saline Embankments in Odisha State. Thus strengthening of total 88.12 Km existing Saline Embankments are undertaken in the project.
- *Page 24 (Section E- Other Outcomes & Impacts; Point 55):* Post Disaster Needs Assessment (PDNA) study has been carried out by NIDM in association with Asian Disaster Preparedness Centre (ADPC), Bangkok. The PDNA Tools for India and Training & Long-Term Recovery Framework were developed under the study. The study was completed in January 2017. The usage of PDNA Tools will provide a scientific and accurate account of damage and the analysis of needs as well of the affected population to enable planned and proper restoration in terms of the Sendai Framework of “Build Back Better”. This would also enable planned deployment of restoration. A one-day National Workshop is to be organised by NIDM to discuss the suggested issues relevant to PDNA and implementation strategy to adopt PDNA Tool.
- *Page 24 (Section E- Other Outcomes & Impacts; Point 56):* A Web based Composite Risk Atlas (Web-CRA) has been developed using deterministic hazard and vulnerability analysis modelling based on historical cyclone events. The web based risk assessment system provides the concerned stakeholders (Decision makers in 13 coastal States/UTs and Central Government) with a comprehensive risk management framework that offers cross-cutting decision support for mitigation planning at all levels of Government-Central, State, District, Taluka/Tehsil/Mandal (Taluka), City/Town and Village. Limited access for viewing to public is also provisioned in the Tool through signing up as Guest User with the portal. This study under NCRMP-I provides a platform for Dynamic and probabilistic risk assessment modelling being carried out under NCRMP –II.
- *Page 40 (Annexure 1- Results Framework & Key Outputs; A.1 PDO Indicators):* Strengthening of total 88.12 Km existing Saline Embankments are undertaken in the project.
- *Page 42 (Annexure 1- Results Framework & Key Outputs; A.2 Intermediate Results Indicators; Component: B):* Total 88.12 Km (29.90 Km in AP and 58.22 Km in Odisha) existing Saline Embankments are completed as on 31st December 2018.



- Page 47 (Annexure 1- Results Framework & Key Outputs; B- Key Outputs by Component; Objective/Outcome 2): Total 1087 Km Roads constructed (698 Km in AP and 389 Km in Odish)
- Page 42 (Annexure 1- Results Framework & Key Outputs; B- Key Outputs by Component; Objective/Outcome 3): Total 88.12 Km (29.90 Km in AP and 58.22 Km in Odisha) existing Saline Embankments strengthened under the project.

Comments from the APSDMA (received on August 21, 2019):

- Para 29 page 14: All the Cyclone Risk Mitigation infrastructure taken up were completed except 1 bridge work i.e., construction of HLB across Buckingham canal at Km. 12/8 of Ongole – Kothapatnam Road in Prakasam District which was delayed due to re-designing for Barge impact. All the other works are completed and bills are to be paid which was delayed due to administrative delays.
- Para 97 page 33: The EWDS equipment provided is sensitive sophisticated and delicate making A.M.C Vital and requires regulated power supply, hence Voltage stabilizers are provided for EWDS Equipment and accordingly provided.
- Para 98 Page 33: The MPCs buildings are being maintained by Cyclone Shelter Maintenance and Management Committees. The State Government has provided a corpus fund of Rs.5.00 Lakhs for regular Management and Maintenance of MPCs. For other major works i.e., Bridges & Roads regular budget under non-plan is being allocated for respective Engineering Line Departments who has technical expertise and knowledge.
- Para 102 page 34: Before procurement of works, the cost estimates are being prepared as per the standard schedule of rates duly considering transportation and material cost. However as suggested the local contexts and sub-project - specific requirements (viz., transportation cost and materials availability) will be analyzed and realistically reflected in cost estimates in addition to the schedule of rates published by governments for future works.
- Para 103 page 34: Redundancy in telecom infrastructure is achieved by resorting to different telecom technologies like Cellular, Wireless/Radio and Satellite Technologies and also ensuring the infrastructure is capable of withstanding high wind speed up to 250 KMPH. For power supply redundancy, inverters with sufficient battery backup is deployed at all EOCs. Also, engine Alternators were already installed as power backup at all MEOCs and the same is being established at the MPCs buildings also.

Comments from the OSDMA (received on August 20, 2019):

- **Paragraph 3.** Orissa State Disaster Mitigation Authority (OSDMA) was set up by the Government of Orissa as an autonomous organization vide Finance Department Resolution No. IFC- 74/99-51779/F dated the 28th December 1999 (in the intermediate aftermath of the Super-cyclone in 1999). It was registered under the Societies Registration Act, 1860 on 29.12.1999 as a non-profit making & charitable institution for the interest of the people of Orissa, with its headquarters at Bhubaneswar and jurisdiction over the whole State. The Department of Revenue is the administrative department of OSDMA vide Revenue Department Resolution No.39373/R dated 26th August 2000. Subsequently, the name of the Authority was changed from Orissa State Disaster Mitigation Authority to Orissa State Disaster Management Authority vide Revenue & Disaster Management Department Resolution No. 42317/R&DM dated 27th September 2008.
- **Paragraph 30.** Odisha State Government has contributed 100% of the corpus fund.
- **Paragraph 34.** 47 villages have donated their land towards raising and strengthening of the saline



embankment. “Luna Bandha Surakhya Samittee” has been formed in 47 and Rs. 5.00 lakhs provided to each Samittee as corpus fund (community development fund). The same amount will be fix deposited in the joint account of the Samittee (Committee) and the interest generate out of the fund would be utilized towards safe, security of the Saline Embankment, some development activities in the village & capacity building activities by the Samittee.



ANNEX 6. SUPPORTING DOCUMENTS (IF ANY)

References

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