

**5<sup>th</sup> World Congress on  
DISASTER MANAGEMENT**



# 5<sup>th</sup> World Congress on DISASTER MANAGEMENT

## Volume 4 DISASTER RESPONSE

*Edited by*

**Dr. S. Ananda Babu**

President and Convenor  
DMICS-WCDM

 **Routledge**  
Taylor & Francis Group  
LONDON AND NEW YORK

**DMICS**  
Disaster Management, Initiatives and Convergence Society  
Envisioning a Disaster Resilient Future

  
WORLD  
CONGRESS ON  
DISASTER  
MANAGEMENT

First published 2023  
by Routledge  
4 Park Square, Milton Park, Abingdon, Oxon OX14 4RN

and by Routledge  
605 Third Avenue, New York, NY 10158

Routledge is an imprint of the Taylor & Francis Group, an informa business

© 2023 DMICS

The right of Dr. S. Ananda Babu to be identified as the author of the editorial material, and of the authors for their individual chapters, has been asserted in accordance with sections 77 and 78 of the Copyright, Designs and Patents Act 1988.

All rights reserved. No part of this book may be reprinted or reproduced or utilised in any form or by any electronic, mechanical, or other means, now known or hereafter invented, including photocopying and recording, or in any information storage or retrieval system, without permission in writing from the publishers.

*Trademark notice:* Product or corporate names may be trademarks or registered trademarks, and are used only for identification and explanation without intent to infringe.

Although the publisher and the author have made every effort to ensure that the information in this book was correct at press time and while this publication is designed to provide accurate information in regard to the subject matter covered, the publisher and the author assume no responsibility for errors, inaccuracies, omissions, or any other inconsistencies herein and hereby disclaim any liability to any party for any loss, damage, or disruption caused by errors or omissions, whether such errors or omissions result from negligence, accident, or any other cause.

British Library Cataloguing-in-Publication Data  
A catalogue record for this book is available from the British Library

Library of Congress Cataloging-in-Publication Data  
A catalog record has been requested for this book

ISBN: 978-1-032-35551-1 (hbk)  
ISBN: 978-1-003-34197-0 (ebk)  
DOI: 10.4324/9781003341970

Print and Bound in India

# Table of Contents

<i>Table of Contents</i>	v
<i>List of Figures</i>	ix
<i>List of Tables</i>	xvii
<i>Preface</i>	xxi
<i>Acknowledgement</i>	xxiii

## Part 1: Building Resilience of Communities to Disasters

<b>1. Indigenous Knowledge and Practices of the Small Ethnic Communities of Asia-Pacific Island Countries in Facing Hydro-meteorological Hazards</b>	<b>3</b>
<i>Mahfuzul Haque</i>	
<b>2. An Inquiry in to Critical Factors of Community Resilience of Tribal Community: A Case of Kerala</b>	<b>10</b>
<i>Geetha A. and Shyni Anil Kumar</i>	
<b>3. Where the Underprivileged Achieve Disaster Resilience: The Dawn of a Self-Sufficient Neighborhood</b>	<b>20</b>
<i>Monisha Makena and Shriya Sahu</i>	
<b>4. Poverty and Disaster Risk Reduction Link for Sustainable Development “A Case Study of Union Councils of District Swabi”</b>	<b>33</b>
<i>Ahmed Faraz Khan</i>	
<b>5. Life with Jihadhal: A Study of Indigenous Knowledge and Practices in Disaster Resilience</b>	<b>43</b>
<i>Annekha Chetia</i>	
<b>6. Redesigning the Community-Based Disaster Risk Management Approach in India with Addition of Risk Perception from the Communities</b>	<b>53</b>
<i>Bhola Saha, D. Saran Prakash, Tanmay Gound and Repaul Kanji</i>	
<b>7. Strengthening Indigenous Capacity for Building Resilience: A Case Study of Community Grain Banks in Palamu, Jharkhand</b>	<b>65</b>
<i>Akanksha Pandey</i>	
<b>8. Indigenous Capacity for Disaster Resilience of the Flood Affected People in Bangladesh</b>	<b>70</b>
<i>Md. Anwar Hossain</i>	
<b>9. Family Preparedness for Disaster Risk Reduction by Engaging Local Governance and Communities in Bihar (India)</b>	<b>80</b>
<i>Geetanjali Kumari, Vivek Kumar Singh, Amritanjali and Amrita Dhiman</i>	
<b>10. Disaster Risk Reduction and the Sendai Framework: What Does it Mean for Bihar Disaster Resilience Practitioners?</b>	<b>87</b>
<i>Sunil Kumar Chaudhary</i>	

## Part 2: Developing Capacity for Building Resilience to Disasters

<b>11. Kautilya’s Antecedents, Contemporary Disaster Resilience: Relevance of Today’s Strengths and Limitations</b>	<b>95</b>
<i>Prof. Priti Diliprao Pohekar</i>	
<b>12. Avhan: Maharashtra Chancellors Brigade: NSS: State Level Training Camp on Disaster Preparedness</b>	<b>101</b>
<i>Shrikrishna Digambar Tupare</i>	
<b>13. Can Disaster Management Capabilities be enhanced through a Well Developed and Structured Training Embedded Capacity Building Strategy?</b>	<b>106</b>
<i>Prayaga M. A.</i>	

<b>14. Hopeful Tomorrow</b>	<b>116</b>
<i>Jaypal Patil</i>	
<b>15. A Study of Community Vulnerability and Capacity in the Context of Climate Change in Majuli, Assam</b>	<b>118</b>
<i>Josephine Nongmaithem</i>	
<b>16. Basic Education on Disaster Management for Saving Lives</b>	<b>127</b>
<i>Bhasker Gupta</i>	
<b>17. Capacity Development for Pri on Disaster Management in the Flood Affected Districts in Bihar</b>	<b>138</b>
<i>Ashok Kumar Sahay and R. B. Singh</i>	
<b>18. Building Resilience Through Disaster Management Perspectives in Higher Education</b>	<b>156</b>
<i>Leena Mahesh Gadkari, Swati Desai and Pankaj Natu</i>	
<b>Part 3: Disaster Preparedness for Response</b>	
<b>19. Military Response to Natural Disasters: The Resilience of Affected Nations</b>	<b>169</b>
<i>Chad A. Long</i>	
<b>20. A Review of Response to COVID 19—IRS as Management Tool</b>	<b>180</b>
<i>V. N. Supanekar</i>	
<b>21. Evacuation of the Transient Population: Review of the Behavioral Aspects and Challenges</b>	<b>187</b>
<i>Suvam Banerjee, Indrajit Ghosh and Rajat Rastogi</i>	
<b>22. Ham Club Station within District EOCs to Reduce Disaster Mortality</b>	<b>198</b>
<i>Kailash Gupta</i>	
<b>23. Assessing the Capacity of Emergency Support Functions (ESFs) for Disaster Response: A Case of Kozhikode District, Kerala</b>	<b>205</b>
<i>Shyni Anilkumar</i>	
<b>24. The Impact of COVID-19 Pandemic on the Institutional Mechanism of Police Force in Akola District</b>	<b>220</b>
<i>Shubham M. Daberao</i>	
<b>25. Safety Up-gradation in Indian Nuclear Power Plants; Education and Preparedness on Disaster Management for First Respondents to Ensure Safety of Plant Personnel and Public</b>	<b>232</b>
<i>R. Sureshkumar, N. N. Pisharody and K. K. De</i>	
<b>26. Fire as a Disaster: Review of Various Prevention, Protection and Management Techniques</b>	<b>242</b>
<i>Sanjeev Kumar Joshi and Amit Kumar Saini</i>	
<b>27. Evolution of Disaster Management in Indian Railways</b>	<b>250</b>
<i>Bhupinder Singla and Samarth Singh</i>	
<b>28. Disaster Communication—Role of Civil Society in Preparedness</b>	<b>258</b>
<i>Harsha Bhargavi Pandiri</i>	
<b>29. Emergence of Grey Water, Past Present and Future: An Overview</b>	<b>266</b>
<i>Sonam Saroha</i>	
<b>Part 4: Resilient Energy and Infrastructure</b>	
<b>30. Seismic Response Evaluation of Electrical Equipment—An Approach for Resilient Power System</b>	<b>279</b>
<i>R. Panneer Selvam and Yamini Gupta</i>	
<b>31. Climate Change Induced Disaster and Resilient Infrastructure In Coastal Area</b>	<b>286</b>
<i>Nur E Alam Md Jobayer Sarwar</i>	
<b>32. A Noble Ultra Low Cost Vibration Detection and Warning System to Avoid Railway Accidents</b>	<b>301</b>
<i>Sanjoy Deb, Saravana Kumar R. and Ramkumar R</i>	
<b>33. Latest Innovations in Optimizing Renewable Energy Systems Infrastructure Efficiency</b>	<b>308</b>
<i>Ashok G. Matani</i>	

<b>34. Resilient Infrastructure: A Paradigm Shift to Safe Structures</b>	<b>312</b>
<i>Ramrakhiyani Juhi</i>	
<b>35. Business Continuity Planning for Rail Infrastructure in India under Multi-hazard Risk Analysis</b>	<b>318</b>
<i>Dheeraj Joshi</i>	
<b>36. Safe and Reliable Railway Operations Through Assessment and Mitigation of Wheel-Slip Risks in Railways</b>	<b>324</b>
<i>Shikha Saini</i>	
<b>37. Assessing the Role of Infrastructure Resilience within Community Resilience in Disaster Management</b>	<b>330</b>
<i>Vidya M. P. and Shyni Anilkumar</i>	
<b>38. An Innovative Approach to Cost Effective Design of Earthquake-Resistant Bridges and Roads</b>	<b>337</b>
<i>Sunil Kumar Chaudhary</i>	
<b>39. Role of Dynamics in Seismic Resilience of Built Structures in India</b>	<b>344</b>
<i>B. M. Raisinghani, T. H. Bhoraniya, A. Kumar, A. Jaiswal and S. G. Shah</i>	
<b>40. Earthquake Risk Reduction: Effective Recovery for Building Sustainable Community Resilience</b>	<b>360</b>
<i>Tanushree Verma</i>	
<b>Part 5: Resilience of Built up Environment</b>	
<b>41. Assessing Building Vulnerability of Indian Cities in Earthquake Zone V</b>	<b>373</b>
<i>Tanushri Kamble and Sarika Bahadure</i>	
<b>42. Risk Assessment and Mitigation of Tehri-Koteswar Road in the Lesser Himalayas, India</b>	<b>392</b>
<i>Koushik Pandit, Mahendra Singh and Jagdish Prasad Sahoo</i>	
<b>43. ‘Blue Economy’ vs ‘Coastal Human Settlements and Their Houses’—A Framework to Identify Similar Construction Methods and Materials</b>	<b>399</b>
<i>K. Sasikala, P. Harikrishna, S. Thamarai Selvi and N. Lakshmanan</i>	
<b>44. Evolution of Humanitarian Shelter Aid Design and Quarantine Housing in COVID 19 Pandemic</b>	<b>408</b>
<i>Kankana Narayan Dev and Amarendra Kumar Das</i>	
<b>45. Buildings in Severe Earthquake Zones Made of Structural Steel Hollow and Plate Members</b>	<b>415</b>
<i>Arup Saha Chaudhuri and Avijit Ghosh</i>	
<b>46. P-Delta Effects on SCWB &amp; WCSB Steel Frames Subject To Seismic Loading</b>	<b>419</b>
<i>Arup Saha Chaudhuri, Ritu parna Chatterjee, Tan moy Banerjee and Uttarayan Chakrabarty</i>	
<b>47. Importance of Risk Allocation for Insuring Large Infrastructure Projects: A Legal Perspective</b>	<b>424</b>
<i>Bhavya Bose, Abhay Dev Sharma and Kartik Baijal</i>	
<b>Part 6: Managing Post Traumatic Stress Disorders in Disasters</b>	
<b>48. Reducing Post-Traumatic Stress Disorder Through Nostalgia Inducing Music: Exploring the Role of Resilience</b>	<b>435</b>
<i>Sahiba Sharma and Gyan Prakash</i>	
<b>49. Managing Post-traumatic Stress Disorders in Disasters: University Students</b>	<b>439</b>
<i>Priyanka Verma and Sheela Misra</i>	
<b>50. Post-traumatic Reactions of Adolescents in a Conflict Region: Findings from an Ethnographic Study on Mental Health in Jammu and Kashmir</b>	<b>447</b>
<i>Urfat Anjem Mir, Kokila Khanna and Anushka Singh</i>	
<b>51. The Impact of Natural Disaster on the Mental Health of Rescue Workers</b>	<b>455</b>
<i>V. Vithya, Neethu P. S. and Amala Sudarsan</i>	
<b>52. Effectiveness of Training Workshop for Health and Mental Health Professionals on Psychosocial Care in Disaster Management</b>	<b>466</b>
<i>Anil Hemanna Doddamani, Sanjeev Kumar Manikappa and Sekar Kasi</i>	

- 53. Samaashraya: An Innovative Mental Health Clinic for Trauma Survivors** 472  
*Dinakaran Damodharan, Channaveerachari Naveen Kumar and Kasi Sekar*
- 54. Training Workshop for Health and Mental Health Professionals on Psychosocial Care in Disaster Management with a Relief Centric to Disaster Risk Reduction Approach** 480  
*Yasir Arafath, Anil Hemanna Doddamani, Sanjeev Kumar Manikappa, Jayakumar C., Tansa K. A. and Sekar Kasi*
- 55. Networking and Knowledge Management for Capacity Building in CESC, a Power Utility in Kolkata** 486  
*Asoke Chakraborty*
- 56. Role of Higher Education in Disaster Preparedness and Management in India** 493  
*Nuzhat Parveen Khan and Ashish Saraswat*

## List of Figures

2.1	<i>Dimensions of community resilience</i>	11
2.2	<i>% of population</i>	12
2.3	<i>Tribal settlement at Sultan Bathery, Wayanadu</i>	14
2.4	<i>Tribal settlement, Attappadi, Palakkad</i>	14
2.5	<i>Literacy prograame</i>	15
2.6	<i>Work participation rate in tribes in Kerala</i>	15
2.7	<i>Tribal house in Idukki</i>	15
2.8	<i>Tribal house in Wayanad</i>	15
2.9	<i>A model tribal colony, Wayanadu</i>	16
2.10	<i>Dimensions of vulnerability</i>	16
2.11	<i>Factors -community resilience</i>	17
3.1	<i>Design and Research Methodology</i>	22
3.2	<i>Proximity Zoning</i>	25
3.3	<i>Site plan and site surroundings showing potential hazards</i>	25
3.4	<i>Cluster layout of unit plans with area 28 Sq.m.</i>	26
3.5	<i>Cluster layout of unit plans with area 30 Sq.m</i>	27
3.6	<i>Sections through clusters</i>	27
3.7	<i>Site plan and site section</i>	28
3.8	<i>Site plan demonstrating various strategies</i>	29
3.9	<i>Construction materials used (a) Bamboo (b) R.C.C. (c) Fly ash brick (d) Bamboo Panels (e) Metal Anchor (f) Bamboo mesh (g) T-shaped plates (h) Cement Plaster</i>	30
3.10	<i>Construction Techniques (a) Masonry to be completed till plinth level, (b) The inside of the wall panel will be mud/ cement plastered, (c) and (d) The outside of the wall will be cement plastered, (e) Cyclone resilient strategies, (f) Joinery details of bamboo, (g) Provisions of holes to insert bamboo later on</i>	30
4.1	<i>Qualification of Respondents</i>	36
4.2	<i>Occupation of people in the study area</i>	36
4.3	<i>Family size in the study area</i>	37
4.4	<i>Types of Houses in the study area</i>	37
4.5	<i>Location of houses in the study area</i>	37
4.6	<i>Exposure to Disasters</i>	38
4.7	<i>Types of disaster in the study area</i>	38
4.8	<i>Early Warning in the study area</i>	38
4.9	<i>Evacuation in the study area</i>	39
4.10	<i>Disaster and livelihood activities</i>	39
4.11	<i>Losses of livelihood assets due to disaster</i>	39
4.12	<i>Unequal Effects of Disasters</i>	39
4.13	<i>Most severly affected people in the study area</i>	40
4.14	<i>Vulnerability of Disables</i>	40

x 5<sup>th</sup> World Congress on Disaster Management

4.15	<i>Accommodation Status in the study area</i>	40
4.16	<i>Disaster mitigation measure in the study area</i>	41
5.1	<i>Map of Jiadhhal Basin</i>	51
5.2	<i>Flood Hazard Zonation Map</i>	51
5.3	<i>Abandoned school</i>	52
5.4	<i>“House on House”</i>	52
5.5	<i>“The 5th house”</i>	52
6.1	<i>Chang Ghar: Houses raised on bamboo sticks.</i>	56
6.2	<i>Earthen pot-making in Salmora.</i>	56
6.3	<i>Murong Okum</i>	57
6.4	<i>Different stakeholders to work collaboratively for DRM in the community</i>	60
6.5	<i>Community-stakeholder partnership</i>	61
6.6	<i>The SGDs Assamese Japi</i>	63
9.1	<i>Major River basin of Bihar</i>	82
9.2	<i>Disaster Risk Based Grouping of Districts in Bihar, India</i>	83
12.1	<i>NSS logo</i>	102
12.2	<i>Rath Wheel of the Konark Sun Temple</i>	102
12.3	<i>Camp training to volunteers</i>	103
12.4	<i>Certificates for volunteers</i>	103
12.5	<i>Felicitation of best volunteers</i>	103
12.6	<i>Ladies Programme officer Participation</i>	103
12.7	<i>Volunteers helped in Rescue.</i>	104
12.8	<i>Blood donation camp</i>	104
12.9	<i>Masks distributions</i>	104
12.10	<i>Donation of Blood &amp; Plasma Paper Clipping</i>	104
12.11	<i>Participation in Republic Parade</i>	105
13.1	<i>Capacity development process flow chart</i>	108
13.2	<i>Capacity Management action domain</i>	109
13.3	<i>Nature of involvement by fishermen</i>	109
13.4	<i>Different steps carried out by the police personnel during Covid-19 situation</i>	110
13.5	<i>Disaster Management Activity- 3 pillars</i>	112
13.6	<i>Disaster Management Activity; pillars - during flood</i>	112
13.7	<i>Steps in DM</i>	112
13.8	<i>Suggestive approach</i>	113
16.1	<i>Phases of Disaster Management Cycle</i>	128
16.2	<i>Effects of Disaster on School</i>	136
17.1	<i>Map of Affected Flood Districts in Bihar 2020</i>	139
18.1	<i>Diagrammatic Representation of responses</i>	161
19.1	<i>City Resilience for Arusha, Tanzania and Carlisle, Pennsylvania</i>	171
19.2	<i>Calculation of the BEH WorldRiskIndex overall risk</i>	172
19.3	<i>BEH WorldRiskIndex exposure values for United States international response efforts</i>	174
19.4	<i>BEH WorldRiskIndex overall risk for United States international response efforts</i>	174

19.5	<i>BEH WorldRiskIndex sustainability values for United States humanitarian response to earthquakes, cyclones, and floods</i>	175
19.6	<i>Natural Hazard Risk Quality Score values for United States humanitarian response to earthquakes, cyclones, and floods</i>	176
19.7	<i>BEH WorldRiskIndex lack of coping capacity values for United States humanitarian response to earthquakes, cyclones, and floods</i>	177
19.8	<i>Countries armed force staffing for the United States humanitarian response to earthquakes, cyclones, and floods</i>	178
21.1	<i>Flow chart of review methodology</i>	188
21.2	<i>Trajectory of the advancing cyclone Fani</i>	191
21.3	<i>Districts affected by Uttarakhand 2013 floods</i>	193
22.1	<i>District Disaster Management Authority, Thiruvananthapuram, Kerala Directing Amateur Radio Society of India to establish amateur radio station at EOC as cyclone Burevi was approaching</i>	200
22.2	<i>Author with Yaesu FT 991A Multiband Transceiver</i>	201
22.3	<i>Author speaking during Workshop on Amateur Radio Awareness at MNIT on World Amateur Radio Day April 18, 2019. Baruah, co-faculty is on the left.</i>	202
22.4	<i>Students of MNIT erecting 25 ft. high antenna</i>	202
23.1	<i>Village wise affected areas, flood 2018, Kozhikode</i>	207
23.2	<i>Indicators of disaster management</i>	210
23.3	<i>Indicators of governance and financial protection</i>	211
23.4	<i>Planning and zoning (DDMA)</i>	211
23.5	<i>Response mechanisms and strategies (DDMA)</i>	211
23.6	<i>Emergency management (DDMA)</i>	211
23.7	<i>Public awareness and training (DDMA)</i>	212
23.8	<i>Overall department analysis</i>	212
23.9	<i>Planning and zoning (HD)</i>	212
23.10	<i>Response mechanisms and strategies (HD)</i>	213
23.11	<i>Emergency management (HD)</i>	213
23.12	<i>Disaster Response Team Training (HD)</i>	213
23.13	<i>Equipment/Technology/Communication (HD)</i>	213
23.14	<i>Overall analysis of Health Department</i>	213
23.15	<i>Indicators of governance and financial protection (F&amp;R)</i>	214
23.16	<i>Planning and zoning (F&amp;R)</i>	214
23.17	<i>Response mechanisms and strategies (F&amp;R)</i>	214
23.18	<i>Emergency management (F&amp;R)</i>	214
23.19	<i>Disaster Response Team (F&amp;R)</i>	215
23.20	<i>Equipment/Technology/Communication (F&amp;R)</i>	215
23.21	<i>Overall department analysis (F&amp;R)</i>	215
23.22	<i>Planning and zoning (Police)</i>	215
23.23	<i>Response mechanisms and strategies</i>	215
23.24	<i>Emergency management (Police)</i>	216
23.25	<i>Disaster Response Team Training (Police)</i>	216
23.26	<i>Equipment/Technology/Communication (Police)</i>	216
23.27	<i>Overall department analysis (Police)</i>	216

23.28	<i>Planning and zoning (NGO)</i>	217
23.29	<i>Response mechanisms and strategies (NGO)</i>	217
23.30	<i>Emergency management (NGO)</i>	217
23.31	<i>Disaster Response Team Training (NGO)</i>	217
23.32	<i>Equipment/Technology/Communication (NGO)</i>	218
23.33	<i>Overall analysis (NGO)</i>	218
23.34	<i>Overall adequacy of response measures</i>	218
23.35	<i>Overall response</i>	218
24.1	<i>Understanding the nature of relationship between actors across departments</i>	227
24.2	<i>Understanding the nature of relationship between actors across departments</i>	227
24.3	<i>Type of Cases (R) and Fine imposed (L) during the first phase and second phase resp.</i>	228
24.4	<i>Crimes happened in Akola District during 2020 and 2021</i>	228
24.5	<i>Number of Police infected by CO VID-19 pandemic</i>	229
25.1	<i>Design Based Flood Level</i>	235
25.2	<i>Flow diagram for Training Need Identification</i>	239
25.3	<i>Hook-up exercise</i>	239
25.4	<i>Hose Layout diagram</i>	240
25.5	<i>Additional DG Sets</i>	240
26.1	<i>Hierarchy of Controls</i>	248
27.1	<i>Trend of Accidents over the years</i>	254
27.2	<i>Accident Sites after derailment</i>	256
27.3	<i>Restoration using 140 Ton Brake Down Crane at Accident Site</i>	256
27.4	<i>Inside View of Self Propelled Accident Relief Medical Van (SPARMV) with Operation Theater Facilities</i>	256
29.1	<i>Sources of Wastewater</i>	266
29.2	<i>Gravel, Stones and Sand media filter (14)</i>	268
29.3	<i>Horizontal Greywater filter. (8)</i>	268
29.4	<i>Sequence Batch Reactor (23)</i>	270
29.5	<i>Constructive Wetland Treatment Method (16)</i>	270
29.6	<i>Typical Constituents of Greywater.</i>	272
29.7	<i>Reuses of Greywater</i>	272
29.8	<i>Decentralized system</i>	272
29.9	<i>Centralized System</i>	273
29.10	<i>Household Greywater Quantity</i>	273
29.11	<i>SWA in diminishing order (11)</i>	274
29.12	<i>Mixed Plumbing Structure</i>	274
29.13	<i>Binary Plumbing Structure</i>	274
30.1	<i>Circuit breaker mounted on shake table</i>	282
30.2	<i>Resonance search – Circuit Breaker</i>	282
30.3	<i>Spectral acceleration</i>	282
30.4	<i>Time history of strain – Circuit Breaker</i>	283
30.5	<i>PMCC mounted on shake table</i>	283
30.6	<i>Resonance search - PMCC</i>	284
30.7	<i>Time history of strain – PMCC</i>	284

<b>31.1</b>	<i>Conceptual Framework constructed by the author - Flow chart</i>	<b>288</b>
<b>31.2</b>	<i>The Adaptive Cycle</i>	<b>289</b>
<b>32.1</b>	<i>(a) The Consequential number of accidents by different category (20 10-2020), (b) number of deaths caused by consequential accidents by category (20 10-17)</i>	<b>302</b>
<b>32.2</b>	<i>The architecture of Real-time Train Alert System</i>	<b>303</b>
<b>32.3</b>	<i>Operation flowchart or algorithm of Real-time Train Alert System</i>	<b>303</b>
<b>32.4</b>	<i>An in-lab Real-time Train Alert System test set-up with LabVIEW</i>	<b>304</b>
<b>32.5</b>	<i>Sketch of laboratory setup for testing RTAS algorithm</i>	<b>304</b>
<b>32.6</b>	<i>LabVIEW model for amplitude based RTAS algorithm verification</i>	<b>305</b>
<b>32.7</b>	<i>LabVIEW model for frequency based RTAS algorithm verification</i>	<b>305</b>
<b>32.8</b>	<i>Amplitude vs. distance curve averaged for five stand alone simulated field experiments</i>	<b>306</b>
<b>32.9</b>	<i>Average frequency vs. time graph for five stand alone simulated experiments</i>	<b>306</b>
<b>34.1</b>	<i>Four dimensions to foster resilience</i>	<b>315</b>
<b>34.2</b>	<i>Some of the benefits of including mitigation in planning process</i>	<b>315</b>
<b>35.1</b>	<i>Business Continuity Planning process</i>	<b>319</b>
<b>35.2</b>	<i>Risk and associated components</i>	<b>320</b>
<b>35.3</b>	<i>Risks in railway zones as per emergency cases</i>	<b>321</b>
<b>35.4</b>	<i>Season-wise risk analysis in Indian Railways</i>	<b>322</b>
<b>35.5</b>	<i>Risk as per seasons in Indian Railways</i>	<b>322</b>
<b>35.6</b>	<i>Risk under emergency cases scenario in IR</i>	<b>322</b>
<b>36.1</b>	<i>After effects of wheel slipping: (L)*Wheel flat, (C)* Rail Burn, (R)** Rail burn due to axle induced slipping in locomotive</i>	<b>324</b>
<b>36.2</b>	<i>Block diagram showing rail wheel interaction dynamics [1]</i>	<b>325</b>
<b>36.3</b>	<i>Adhesion Characteristic curve (L) and Effect of weather (rail conditions) on adhesion [3]</i>	<b>325</b>
<b>36.4</b>	<i>Possible control algorithm of conventional control [6]</i>	<b>326</b>
<b>36.5</b>	<i>Single wheel-rail model</i>	<b>327</b>
<b>36.6</b>	<i>Confusion matrix for slip control</i>	<b>328</b>
<b>36.7</b>	<i>Driver display messages for a false wheel slip in electric locomotive of IR.</i>	<b>328</b>
<b>37.1</b>	<i>Community with different infrastructure system</i>	<b>331</b>
<b>37.2</b>	<i>Steps in Bibliometric analysis</i>	<b>333</b>
<b>37.3</b>	<i>Word cloud showing prominent keywords</i>	<b>334</b>
<b>37.4</b>	<i>Thematic evolutions of studies</i>	<b>334</b>
<b>37.5</b>	<i>Most relevant sources</i>	<b>334</b>
<b>37.6</b>	<i>Most cited countries</i>	<b>335</b>
<b>37.7</b>	<i>Co-occurrence network of author keywords</i>	<b>335</b>
<b>38.1</b>	<i>Confinement of column sections by transverse and longitudinal reinforcement</i>	<b>338</b>
<b>38.2</b>	<i>Well-designed structures dissipate seismic energy by inelastic deformations in localized zones of selected members</i>	<b>339</b>
<b>38.3</b>	<i>Surajbari Old Bridge: Metallic bearings destroyed during earthquake</i>	<b>339</b>
<b>38.4</b>	<i>Girder shifted in the longitudinal direction with loss of seating during shaking</i>	<b>339</b>
<b>38.5</b>	<i>Example of longitudinal seismic restrainer for continuous bridges</i>	<b>340</b>
<b>38.6</b>	<i>Longitudinal seismic restrainer (vertical elastomeric pad introduces damping to Longitudinal forces)</i>	<b>340</b>
<b>38.7</b>	<i>Prevention of dislodgement</i>	<b>340</b>

38.8	<i>Minimum dimensions for support lengths (after IRC (2000) and AASHTO (1999))</i>	341
38.9	<i>Elastic response spectrum</i>	341
38.10	<i>Base isolation and energy dissipation (two in one)</i>	341
38.11	<i>Shock Transmission Unit – The principle</i>	342
39.1	<i>Plan and section details of 15-storey RC building</i>	346
39.2	<i>Seismicity mapping in Gujarat state by ISR-GERI (2008)</i>	347
39.3	<i>Pictorial description of the seismicity and the tectonic regions of India</i>	347
39.4	<i>Response spectrum comparison for different time history records and code response spectrum</i>	348
39.5	<i>Features of ETABS for response spectrum and matched response spectrum</i>	349
39.6	<i>Definition of rules for earthquake analysis of buildings through modeling</i>	350
39.7	<i>Eigen solution for the building for the three design cases</i>	351
39.8	<i>Reinforcement details of column with highest rebar requirement</i>	351
39.9	<i>Comparison of force diagrams for frame and pier elements</i>	352
39.10	<i>Comparison of displacement of building under lateral load in X-direction</i>	353
39.11	<i>Performance point for the 15-storey building for three design cases</i>	353
39.12	<i>Base shear and drift for pushover analysis for the three design cases of 15-storey building</i>	354
39.13	<i>Comparison of column section analysis for TEC07</i>	355
39.14	<i>SEMAp output for section analysis models - IS designed column</i>	355
39.15	<i>Displacement response spectrum for the building – linear and nonlinear spectrum</i>	355
40.1	<i>Figure to the top showing plot of Earthquakes (M&gt;= 5.0) from IMD Catalogue for the period from 1800 to Sept. 2001 (Total events 3353)</i>	363
40.2	<i>Tectonic Map of India: Black lines showing active fault zones</i>	363
41.1	<i>Urbanization and cities population as expected in 2030 (UN, 2019)</i>	374
41.2	<i>Multi-hazard map of India</i>	375
41.3	<i>Network analysis diagram for performed analysis</i>	376
41.4	<i>Earthquake hazard map, India</i>	378
41.5	<i>Building vulnerability across earthquake zone V cities</i>	380
42.1	<i>Static loading scenario with pore water pressure co-efficient <math>R_u = 0.0</math> for various slope sections</i>	395
42.2	<i>Static loading scenario with pore water pressure co-efficient <math>R_u = 0.1</math> for various slope sections</i>	396
42.3	<i>Pseudo-static loading (<math>\alpha_H = 0.15</math>) scenario with pore water pressure co-efficient <math>R_u = 0.0</math> for various slope sections</i>	397
42.4	<i>Slope geometry with piles installed</i>	398
42.5	<i>Safety factors for different spacing to pile diameter ratios (dia. of 0.1 m was kept constant)</i>	398
43.1	<i>Survey sheet of NARIMANAM village of Tamil Nadu, India—Portion of manual data entry sheet</i>	401
43.2	<i>Excel sheet generated from the manual data entry survey sheet of NARIMANAM village Tamil Nadu, India</i>	401
44.1	<i>Maison Dom-ino</i>	409
44.2	<i>Super Blocks</i>	409
44.3	<i>Dymaxion House by Buckminster Fuller</i>	409
44.5	<i>A Typical Levittown</i>	410
44.4	<i>Sears Kit Homes</i>	410
44.6	<i>View of a Post -2019 Flood Relief Camp in Chirang District of Assam</i>	411
44.7	<i>Map Showing Functional areas in the Ground Floor of Quarantine Building of capacity 600 at Chawla, New Delhi by ITBP</i>	413

<b>44.8</b>	<i>Sarusajai Quarantine Facility, Guwahati, Assam</i>	<b>413</b>
<b>44.9</b>	<i>Villagers in Manipur's Tunglejoi have set up 80 huts for COVID-19 quarantine. (Photo  Twitter/@DrJitendraSingh)</i>	<b>414</b>
<b>45.1</b>	<i>Building Plans and Elevations</i>	<b>417</b>
<b>46.1</b>	<i>Elevation of Building Frame</i>	<b>420</b>
<b>46.2</b>	<i>Steel SCWB Nodal Displacement Graphs</i>	<b>422</b>
<b>46.3</b>	<i>Steel WCSB Nodal Displacement Graphs</i>	<b>422</b>
<b>48.1</b>	<i>Nostalgia antecedents and consequences along with its characteristics</i>	<b>436</b>
<b>48.2</b>	<i>Framework proposed by authors</i>	<b>436</b>
<b>49.1</b>	<i>When students feel stressed</i>	<b>441</b>
<b>49.2</b>	<i>Whom do you share when you feel stressed?</i>	<b>442</b>
<b>49.3</b>	<i>Feel better after sharing problems</i>	<b>442</b>
<b>49.4</b>	<i>What do you do to reduce or manage stress?</i>	<b>443</b>
<b>49.5</b>	<i>Rate of life stress during Covid-19 pandemic (1-5 scale)</i>	<b>443</b>
<b>49.6</b>	<i>Issues that cause stress</i>	<b>443</b>
<b>49.7</b>	<i>How respondents manage stressful situations</i>	<b>443</b>
<b>51.1</b>	<i>Indicates the proposed model obtained through path analysis</i>	<b>459</b>



## List of Tables

2.1	<i>Tribes and their location</i>	12
2.2	<i>Tribal population in different districts Kerala</i>	12
2.3	<i>Socio-cultural context of the Primitive tribes in Kerala</i>	13
2.4	<i>Literacy rate of tribals in districts</i>	14
3.1	<i>Cost approximation for one unit</i>	31
4.1	<i>Sample Size Selection village wise in District Swabi</i>	35
4.2	<i>Land owned by the family in the study area</i>	37
4.3	<i>Extent to which livelihood activities affected</i>	39
4.4	<i>Poverty and Disaster Vulnerability</i>	40
4.5	<i>Measures to reduce the severe impacts of disaster on the poor people in the study area</i>	41
5.1	<i>Flood Hazard zonation of Jiadhal River Basin</i>	51
8.1	<i>Distribution of Roles Performed by Men and Women in Pre-disaster Phase</i>	73
8.2	<i>Participation in Decision-making in Preparedness Phase by Sex</i>	74
8.3	<i>Distribution of Problems Faced by the People during Floods by Sex</i>	75
8.4	<i>Distribution of Coping Mechanisms of the Respondents with Floods</i>	76
8.5	<i>Relationship between Income and Coping Mechanisms</i>	77
10.1	<i>Comparison of key concepts between two relevant glossaries</i>	88
15.1	<i>Sampling Framework of the Study</i>	120
15.2	<i>Methods of data collection</i>	120
15.3	<i>Tools for data collection</i>	120
16.1	<i>Benefits of Early Childhood Education</i>	131
16.2	<i>Structure of Proposed IDMP Curriculum at UG level</i>	133
16.3	<i>NSSP and its Objectives</i>	135
17.1	<i>Yearly flood deaths from 1979 to 2017</i>	141
17.2	<i>Total Affected and Damaged in Bihar due to flood 1979–2006</i>	142
18.1	<i>Table of Observed frequencies</i>	160
18.2	<i>Table of Expected frequencies</i>	160
19.1	<i>FM Global Resilience Index factors and drivers</i>	171
19.2	<i>BEH WorldRiskIndex average exposure and overall risk values by the geographic combatant commander</i>	173
19.3	<i>Average and Median Natural Hazard Risk Quality Score by Geographic Combatant Command</i>	176
23.1	<i>Roles and responsibilities of ESFs</i>	208
23.2	<i>Checklist of Response Indicators</i>	209
24.1	<i>Akola District Covid-19</i>	220
24.2	<i>Nationwide CO VID-19 Impact on Police Forces</i>	221
25.1	<i>Defense in Depth</i>	236
25.2	<i>Matrix of 9 Model</i>	236
26.1	<i>Benchmark events in the development of fire safety engineering &amp; regulations</i>	243
26.2	<i>Classification of Fire in India, UK, USA and Australia</i>	244
26.3	<i>Fire Classification Vs Extinguishing media and Methods</i>	245

**xviii** 5<sup>th</sup> World Congress on Disaster Management

<b>27.1</b>	<i>Railway accidents in India (1980–2020)</i>	<b>253</b>
<b>30.1</b>	<i>Resonance Frequencies</i>	<b>282</b>
<b>30.2</b>	<i>No-Load Time Measurement</i>	<b>283</b>
<b>30.3</b>	<i>Resonance Frequencies</i>	<b>284</b>
<b>30.4</b>	<i>Main Circuit Resistance Measurement</i>	<b>284</b>
<b>31.1</b>	<i>Climate Change Impacts on Coastal Zone Infrastructure (Interview, 2021)</i>	<b>291</b>
<b>31.2</b>	<i>General Climate Proofing Options</i>	<b>292</b>
<b>31.3</b>	<i>Year wise policy Initiatives in Bangladesh</i>	<b>292</b>
<b>31.4</b>	<i>Allotment of BCCTF (2009–2017)</i>	<b>294</b>
<b>31.5</b>	<i>Important Coastal Projects Under BCCSAP &amp; PPCR</i>	<b>295</b>
<b>31.6</b>	<i>Resilient Concepts and Policy in CA</i>	<b>296</b>
<b>32.1</b>	<i>A comparative accuracy analysis for amplitude and frequency based detection</i>	<b>306</b>
<b>34.1</b>	<i>Countries having higher death rate due to Natural Disasters (1997-2017)</i>	<b>314</b>
<b>34.2</b>	<i>Number of earthquakes of magnitude ranging from 5.0 to 8.0+ in various seismic region of India</i>	<b>314</b>
<b>34.3</b>	<i>Examples of extreme earthquake events in India</i>	<b>314</b>
<b>35.1</b>	<i>Railway infrastructure and their impact under hazards</i>	<b>319</b>
<b>37.1</b>	<i>Capacities assessed for community resilience (Lucy Faulkner, 2018)</i>	<b>333</b>
<b>39.1</b>	<i>Mass and storey stiffness in X-direction for eigen solution in MATLAB</i>	<b>350</b>
<b>39.2</b>	<i>Comparison of performance point for three design codes</i>	<b>354</b>
<b>39.3</b>	<i>Inter-storey drift (ISD) estimates in MATLAB program</i>	<b>356</b>
<b>40.1</b>	<i>Some Significant Earthquakes in India</i>	<b>364</b>
<b>41.1</b>	<i>Recent disasters in India in the last century (GoI, 2011)</i>	<b>375</b>
<b>41.2</b>	<i>Deleted words from the network analysis</i>	<b>377</b>
<b>41.3</b>	<i>Cities in earthquake zone V</i>	<b>377</b>
<b>41.4</b>	<i>Building vulnerability for Bhuj</i>	<b>379</b>
<b>41.5</b>	<i>Statistics for building vulnerability in the cities of earthquake zone V</i>	<b>380</b>
<b>41.A1</b>	<i>Building vulnerability for Darbhanga urban area</i>	<b>383</b>
<b>41.A2</b>	<i>Building vulnerability for Guwahati urban area</i>	<b>385</b>
<b>41.A3</b>	<i>Building vulnerability for Imphal urban area</i>	<b>386</b>
<b>41.A4</b>	<i>Building vulnerability for Jorhat urban area</i>	<b>387</b>
<b>41.A5</b>	<i>Building vulnerability for Kohima urban area</i>	<b>388</b>
<b>41.A6</b>	<i>Building vulnerability for Mandi urban area</i>	<b>388</b>
<b>41.A7</b>	<i>Building vulnerability for Srinagar urban area</i>	<b>389</b>
<b>41.A8</b>	<i>Building vulnerability for Tezpur urban area</i>	<b>391</b>
<b>42.1</b>	<i>Shear strength parameters and unit weights of debris material from laboratory large direct shear tests</i>	<b>394</b>
<b>42.2</b>	<i>Shear strength parameters and unit weights of Phyllite rock mass from Geological Strength Index evaluated at site</i>	<b>394</b>
<b>42.3</b>	<i>Factor of safety values for the studied slopes using Spencer’s limit equilibrium method</i>	<b>398</b>
<b>43.1</b>	<i>Selected 3 parameters for ‘Non-Engineered houses’ for ‘NARIMANAM’ village</i>	<b>402</b>
<b>43.2</b>	<i>Selected 3 parameters for ‘Non-Engineered houses’ for ‘NARIMANAM’ village</i>	<b>402</b>
<b>43.3</b>	<i>Selected 3 parameters for ‘Engineered houses’ for ten villages</i>	<b>402</b>
<b>43.4</b>	<i>For each village, 3 houses for Non-Engineering type, 2 houses for semi-Engineering type, and 1 house for Engineering type 31+20+10 =61, has been taken</i>	<b>403</b>
<b>43.5</b>	<i>Matlab output table for 1, 2, 3 item-set with support</i>	<b>404</b>
<b>43.6</b>	<i>Most frequent item-set with support 0.36</i>	<b>404</b>

43.7	<i>2nd Most frequent itemset with support 0.16</i>	404
43.8	<i>3rd Most frequent item-set with support 0.15</i>	405
44.1	<i>List of Design Criteria based on the essential qualities of human necessities</i>	411
44.2	<i>List of Design Criteria based on the spatial requirements and functions</i>	412
44.3	<i>List of Design Criteria based on the Humanitarian Standards</i>	412
46.1	<i>Cross Section Properties</i>	420
46.2	<i>Nodal Horizontal Displacement Values</i>	421
46.3	<i>Variation of Nodal Horizontal Displacements</i>	421
46.4	<i>Steel Frame Results</i>	421
48.1	<i>Demographic</i>	437
49.1	<i>Demographic details</i>	441
49.2	<i>Chi-Square Tests</i>	444
49.3	<i>Chi-Square Tests</i>	444
49.4	<i>Chi-Square Tests</i>	444
49.5	<i>Chi-Square Tests</i>	444
49.6	<i>Chi-Square Tests</i>	445
49.7	<i>Chi-Square Tests</i>	445
49.8	<i>Chi-Square Tests</i>	445
49.9	<i>Chi-Square Tests</i>	445
50.1	<i>Presents the nature of the traumatic event as narrated by the participants</i>	449
50.2	<i>Presents details of Trauma Experience</i>	449
51.1	<i>Inter Relationship between depression, anxiety, stress, post-traumatic stress disorder and four domains of quality of life</i>	457
51.2	<i>Indicates the chi square value of the model obtained by path analysis</i>	459
51.3	<i>Indicates the RMSEA value of the model obtained by path analysis</i>	459
51.4	<i>Indicates the GFI value of the model obtained by path analysis</i>	459
51.5	<i>Indicates the SRMR value of the model obtained by path analysis</i>	459
51.6	<i>Indicates the NFI and CFI value of the model obtained by path analysis</i>	460
51.7	<i>Displays the themes and sub themes arisen from thematic analysis</i>	460
52.1	<i>Socio-Demographic Details of participants</i>	468
52.2	<i>Mean Score of Pre and Post assessment of Measurements</i>	468
52.3	<i>Mean Score of Feedback</i>	468
53.1	<i>Team and functions of Samaashraya clinic</i>	474
53.2	<i>Characteristics of Individuals reaching Samaashraya Clinic</i>	474
54.1	<i>Socio-demographic details of the Participants</i>	482
54.2	<i>Mean Score of Pre and Post assessment of Measurements</i>	482
54.3	<i>Mean Score of Feedback</i>	483



# Preface

The Fifth World Congress on Disaster Management (WCDM) was organised in Delhi from 24<sup>th</sup> to 27<sup>th</sup> November 2021 jointly by the Government of Delhi, the Indian Institute of Technology Delhi, and the Disaster Management Initiative and Convergence Society which created the platform of WCDM. Over the years, WCDM has emerged as the largest conference on disaster management in the developing world.

The theme of the Fifth WCDM was *Technology, Finance and Capacity*. 7 Plenary Sessions, 50 Technical Sessions and Special Technical Sessions were organised around this overarching theme. While eminent thought leaders and experts delivered keynote addresses and participated in the panel discussions of the Plenary Sessions. It is the Technical Sessions that received the longest traction as Call for Papers was issued for these sessions months in advance and more than 600 researchers, practitioners and policy makers responded with abstracts of their ideas. These were reviewed by experts and subsequently, 250 of these abstracts were developed as full papers. This is the fourth of the five-volume series of compendium of these papers.

The papers have been published in the same form these were received without any peer review to provide a flavour of the raw ideas that emerged from the Technical Sessions of the conference. Some of these papers presented by the young researchers and practitioners may not have the rigours of academic disciplines, but these do reflect the cross current of thoughts that went around in these sessions of the Conference. These provide new ideas and insights that provide value to the current discourses on the subject.

These papers have been arranged under five broad themes– first: Disaster Risk Management, second: Nature and Human Induced Disasters, third: Coronavirus Pandemic, fourth: Disaster Response and fifth: Challenges and Opportunities of Disaster Management. Understandably the papers do not cover every aspect of the themes, these discuss only those aspects that the authors have chosen to highlight. The present volume is a compilation of 56 papers on the theme of Disaster Response which is further divided into six sub-themes, first: Building Resilience of Communities to Disasters, second: Developing Capacity for Building Resilience to Disasters, third: Disaster Preparedness for Response, fourth: Resilient Energy and Infrastructure, fifth: Resilience of Built-up Environment and sixth: Managing Post Traumatic Stress Disorders in Disasters.

The Conference secretariat has brought the papers together, but his credit lies solely and exclusively on the authors.

**Dr S. Ananda Babu**  
**Convener**  
**Fifth World Conference on Disaster Management**



# Acknowledgement

DMICS, the organizer of the 5<sup>th</sup> World Congress on Disaster Management (WCDM), expresses its deep appreciation to Government of Delhi (GNCTD), NDMA, NIDM, DRDO, UNICEF, ICMR, GSI, and Knowledge Partners, delegates who have supported the 2021 World Congress on Disaster Management with either earmarked or unearmarked contributions. A special acknowledgement goes to Indian Institute of Technology, Delhi for hosting the 5<sup>th</sup> WCDM for its strong support.

DMICS would like to express our deepest appreciation to Hon'ble Union Minister of Defence, Shri Rajnath Singh for inaugurating the 5<sup>th</sup> WCDM and delivering the inaugural address; Mami Mizutori, UN-DRR Chief and Special Representative of the UN Secretary General for her special message and Dr Balram Bhargava, Secretary, DHR and Director General, ICMR for his key note address. We would also like to convey our heartfelt appreciation and gratitude to Prof. V. Ramgopal Rao, Director of IIT Delhi, Dr. Parvez Hyatt, for their strategic support and guidance. Our indefatigable team members, Col. Sanjay Srivastava, Dr. Chandrappa, Dr. A. Kishan, Prof. B. Gopal Rao, Mr. Bhaskar Rao Volam, Dr. B. Ram, Prof. V. Prakasam, Dr. A. Gayathri Devi, Dr. R.K. Srivastava, Mr. Amit Kumar, Mr. Mohan Kasthala, Mr. Pavan Parlapalli, Mr. Manish Vishnoi, Ms. Suparna Dutta, Ms. Parul Sharma, Ms. Megha B Bhati, M. Zoya Khan, Ms. Areeba Naaz, Mr. Rohit Kumar Azad and Ms. Shweta Zanjrukia, deserve a huge appreciation for working tirelessly for the last one year in ensuring that 5th WCDM reaches new horizons in bringing together the Government Duty bearers, Policy makers, Planners, Researchers, Academicians, Practitioners and other key stakeholders.

DMICS extends its sincere gratitude to the large number of organisations, individuals and volunteers who have contributed to the 5<sup>th</sup> WCDM, through technical support and in numerous other ways. DMICS would like to express its deepest appreciation also to the members of the Scientific and Technical Committee (S&TC) along with its Chair, technical leads and collaborative organisations of Pre-Conference Webinars, Plenaries, Special Feature Events, Special Technical Sessions and Exhibitors.

