EANGAGE

Dialogues on Connectivity between Europe and Asia

The Next Gen EU-ASEAN Think Tank Dialogue

Co-funded by the European Union

KONRAD ADENAUER STIFTUNG

HỌC VIỆN NGOẠI GIAO DAV

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FOREWORD

"Sustainable, Comprehensive and Rules-Based Connectivity will contribute to the enhanced prosperity, safety and resilience of people and societies in Europe and Asia."[1]

The COVID-19 pandemic was a vivid reminder of the inter-connectedness of our modern world. As the world moves forward from the pandemic and strives to build back better, the pandemic also serves to demonstrate that connectivity is not just an inescapable part of our daily lives, but is also essential for economic growth, prosperity and security. Not surprisingly, connectivity has become a high priority in both national and international policy agendas.

The European Union (EU) has long been a champion of connectivity, an approach that predates the pandemic. In 2018, the EU laid out its vision and strategy for connecting Europe and Asia, signalling early on its commitment to building partnerships and networks in Asia. The commitment to connectivity is reiterated in the EU's Global Gateway launched in 2021.

In December 2022, the EU and the Association of Southeast Asian Nations (ASEAN) commemorated 45 years of diplomatic relations. The ASEAN countries as a group are the EU's third largest trading partner outside Europe.[2] 10 million people travel between the two regions each year.[3] However, as engagement between the two regions deepens, the opportunities created by greater connectivity also present challenges.

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1 eeas.europa.eu. Connecting Europe and Asia: the EU Strategy. (https://www.eeas.europa.eu/sites/default/files/eu-asian_connectivity_factsheet_september_2019.pdf_final.pdf).

2 policy.trade.ec.europa.eu. Association of Southeast Asian Nations: EU trade relations with the Association of Southeast Asian Nations. Facts, figures and latest developments. (https://ec.europa.eu/trade/policy/countries-and-regions/regions/asean/).

3 eeas.europa.eu. EU ASEAN Strategic Partnership. (https://www.eeas.europa.eu/sites/default/files/fact-sheet-eu-asean-strategic-partnership.pdf).

While connectivity has become a buzzword in policy circles, what does it mean in practice? How can better connectivity be effectively implemented? How can the potential of connectivity be harnessed for maximum impact? How can greater connectivity be aligned with sustainability?

This book is therefore a timely resource for academics and policy practitioners alike to delve deeper into the issues of connectivity. This book is a collection of papers by young researchers from the EU and ASEAN that explores some of these questions.

This book is part of a three-volume set of research papers produced under the project "Think Next, Act Next – The Next Gen EU-ASEAN Think Tank Dialogue" (EANGAGE), which aims to encourage greater collaboration between the EU and ASEAN, inspire joint research and foster greater awareness of the EU's engagement in the ASEAN region. Co-funded by the European Union, the two-year project was launched in 2021. The Konrad-Adenauer-Stiftung with its Regional Programme Political Dialogue Asia is privileged to be one of the partners for this project, and focused on research in the area of connectivity. The two other partners for the project, the Asian Vision Institute, Cambodia and the Diplomatic Academy of Vietnam, were responsible for facilitating research in the areas of sustainable development and security respectively.

Although connectivity is often most closely associated with digital connectivity, the papers in this volume follow the EU's broader concept of connectivity to encompass the physical, institutional, human (or people-to-people) and digital dimensions.

The papers in this volume examine the current initiatives and progress in connectivity between the two regions. From a broad overview of the strategic partnership to more in-depth analysis, the papers cover a spectrum of relevant policy issues, ranging from smart cities, artificial intelligence, supply chains, trade, food security, vaccine diplomacy, digitalisation and technology to the challenges of environmental change. The papers highlight best practices and case studies, and offer concrete policy recommendations and practical solutions to further the connectivity agenda in both regions.

The book brings together the extensive experience, expertise and knowledge of young researchers across the EU and ASEAN. The young research fellows of the EANGAGE project worked together across different time zones and geographies and most of them also collaborated to write research in a non-native language. This is a true testament to the spirit of EU-ASEAN coop-

eration. The insights provided by these papers should contribute to a better understanding of EU-ASEAN cooperation. We hope that the book will be well-received and become the "go-to" guide on connectivity for researchers and policymakers in both Europe and Asia.

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- Dr. Frederick Kliem, Research Fellow and Lecturer, Rajaratnam School of International Studies, Nanyang Technological University, Singapore
- Dr. Yeo Lay Hwee, Director, European Union Centre, Singapore

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The publication is the outcome of close cooperation and teamwork between the consortium partners, the Konrad-Adenauer-Stiftung, the Asian Vision Institute (AVI) and the Diplomatic Academy of Vietnam (DAV). The project leaders for each of the consortium partners – Konrad-Adenauer-Stiftung, Singapore, Asian Vision Institute and the Diplomatic Academy of Vietnam – provided critical advice and direction for the project, including this publication. The project was also ably supported by the EU Projects Team at the Konrad-Adenauer-Stiftung, Berlin.

The programme managers for each cluster, connectivity, sustainable development and security, worked tirelessly to produce this volume. The programme managers were responsible for coordinating the research with all the fellows involved, including facilitating the mentoring of the research papers and ensuring the process of research collaboration was completed smoothly.

Finally, the support of colleagues and staff (including the finance and administrative team) from Konrad-Adenauer-Stiftung, Singapore, the Asian Vision Institute and the Diplomatic Academy of Vietnam was also critical in the production of this volume.

04

Environmental Issues in the Mekong River Region

A Mitigation Model Based on Information and Communications Technology

Riccardo Corrado | Audrey Liwan | Upalat Korwatanasakul

Abstract

The Mekong River Basin region is highly dependent economically on the Mekong River through several activities. These activities, in many cases unregulated and uncontrolled, have been causing environmental damage to the river, affecting its flow, chemical composition, and biosystem. In addition, one of the major issues that have sharply arisen in recent years is the increasing number of dams deployed for energy production, severely disrupting the water flow downstream and causing droughts and flooding in the lower river path areas. Education and financial-related interventions represent traditional ways to tackle these issues affecting the Mekong River. But there are other opportunities available. Specifically, Information and Communications Technology (ICT) can present themselves as real changemakers. Yet, a multi-dimensional application of ICT to tackle environmental issues related to the Mekong River can foster change, but only if a common approach and framework are agreed upon and followed by all the involved actors. To answer this, this paper presents a three-pillar model of approaches leveraging ICT affordances. This mitigation model is based on three pillars: behavioural approach, smart approach, and alternative energy approach. The proposed model should represent a starting point in the stakeholders' discussion for creating a shared roadmap.

INTRODUCTION

The Mekong River originates from the Tibet Plateau and passes through six countries: China, Laos, Myanmar, Thailand, Cambodia, and Vietnam[1]. The river and its tributaries represent an important world contributor in terms of aquatic biodiversity and production. The Mekong River Basin (MRB) is generally divided into two sub-basins, namely the Upper Mekong Basin (UMB), which is known as the Lancang River in China, and the Lower Mekong Basin (LMB), which flows through five countries[2].

Over the past decades, the Greater Mekong Subregion (GMS) has experienced significant environmental impacts caused by many environmental factors, but mainly driven by the increasing construction of hydropower dams along the river[3], causing a serious threat to the ecosystem, in addition to the already existent issues related to climate change[4]. The development and implementation of technology-driven solutions revolving around the usage of Information and Communications Technology (ICT) have shown themselves to be a critical asset for addressing climate change and environmental issues and thus represent a powerful tool in the race toward the Sustainable Development Goals (SDGs)[5]. Artificial Intelligence (AI), and the Internet of Things (IoT), enabled by the increasing connectivity in the region, have already shown themselves to be robust solutions used by ASEAN member states (AMS) for fighting ocean pollution, monitoring and controlling waste management, and improving urban planning[6].

But if the usage of ICT may represent a changemaker, the solution cannot be defined by technology itself but rather by its implementation for support-

1. Li et al. 2017. Observed Changes in Flow Regimes in the Mekong River Basin.

2. Li et al. 2017.

3. Corrado, Liwan, and Korwatanasakul. 2022. Information & Communications Technology Solutions for Environmental Issues in the Greater Mekong Subregion.

4. Korwatanasakul and Durongkaveroj. 2021. Water Politics in the Greater Mekong Subregion: Implications and Challenges on Thailand's Border Trade and Inbound Labour Immigration.

5. Corrado, Liwan, and Korwatanasakul. 2022. Information & Communications Technology Solutions for Environmental Issues in the Greater Mekong Subregion.

6. Corrado, Liwan, and Korwatanasakul. 2022.

ing a mitigation strategy. In this paper, we offer a framework based on three pillars to highlight how technology can represent a common fundamental factor in fostering change in the GMS, fighting the environmental impacts on the Mekong River and their effects on the MRB, and thus representing a valuable tool to support the race toward the SDGs for the AMS.

ISSUES IN THE MEKONG RIVER BASIN

Over the last few decades, the MRB has been subject to changes caused by climate change[7] and developmental plans, specifically changes mainly driven by the construction of a large number of hydropower dams[8]. The history of dam development in the MRB dates to 1965 in northeastern Thailand when the Nam Pung Dam was built in Sakon Nakhorn Province, followed by the development of the upper Chi River Sub-basin in Khon Kaen Province with its official inauguration the following year[9]. The MRB hydropower dam development saw a dramatic increase in 2010, particularly in Laos, China, and Cambodia, with Laos itself hosting 61 hydropower dams by the first half of 2019[10]. The exponential dam development has introduced several issues such as induced relocation of entire villages to higher ground with non-suitable resettlement for those displaced, loss of agricultural and forest lands and lands for grazing, deforestation[11], adverse effects on farming[12], and negative

7. Korwatanasakul and Durongkaveroj. 2021. Water Politics in the Greater Mekong Subregion: Implications and Challenges on Thailand's Border Trade and Inbound Labour Immigration.

8. Soukhaphon, Baird, and Hogan. 2021. The Impacts of Hydropower Dams in the Mekong River Basin: A Review.

9. Soukhaphon, Baird, and Hogan. 2021.

10. Soukhaphon, Baird, and Hogan. 2021.

11. Soukhaphon, Baird, and Hogan. 2021.

12. Nguyen et al. 2019. Farmer Adoptability for Livelihood Transformations in the Mekong Delta.

impacts on agriculture and rice production[13]. Additionally, dams and their adjacent reservoirs affect the flow regime of the river.

This process of controlling water flow has caused many issues with record droughts. One example is represented by the drought of July 2019 in Thailand, when the government had to mobilise its military to respond to a drought emergency in its northeast provinces[14]. The same issues were also faced by Cambodia and Vietnam. Cambodian fishing communities alongside the Tonle Sap Lake reported a dramatic reduction of up to 90 per cent of the fishery product, with some highly populated portions of Vietnam's Mekong Delta having lost complete access to fresh water[15]. In addition, unregulated water management[16] with control and release of the Mekong River water in the UMB has caused severe issues for the LMB, with Thailand and Cambodia suffering the most from it[17]. Regarding this, the communities in Chiang Rai Province in the northern part of Thailand have several times voiced their complaints over sudden and unexpected rises in the levels of the Mekong River, particularly during the dry season, causing severe damage to riverside farms, livestock and farming equipment stored on the riverside[18]. Thailand and, similarly, Cambodia, are subject to these issues, with these sudden unnatural flows of water contributing to changes in the Tonle Sap Lake, "where both the extreme high waters of the monsoons and the low waters of the dry season are needed to produce the lake's annual expansion and contraction that generates a fish catch of more than 500,000 tons for Cambodia"[19].

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13. Kontgis et al. 2019. Climate Change Impacts on Rice Productivity in the Mekong River Delta; Triet et al. Future Projections of Flood Dynamics in the Vietnamese Mekong Delta.

14. Eyler, Kwan, and Weatherby. 2020. How China Turned Off the Tap on the Mekong River.

15. Eyler, Kwan, and Weatherby. 2020.

16. Whitehead et al. 2019. Water Quality Modelling of the Mekong River Basin.

17. Li et al. 2017. Observed Changes in Flow Regimes in the Mekong River Basin; Sabo et al. 2017. Designing River Flows to Improve Food Security Futures in the Lower Mekong Basin; Winemiller et al. 2016. Balancing Hydropower and Biodiversity in the Amazon, Congo, and Mekong.

18. Eyler, Kwan, and Weatherby. 2020. How China Turned Off the Tap on the Mekong River.

19. Eyler, Kwan, and Weatherby. 2020.

Another vital issue to consider is the unregulated mining of sediment extraction[20]. It is essential to highlight how the sediment load of the LMB plays a crucial role in the socioeconomic sustainability of the Mekong River basin[21]. Dams disrupt the downstream transport of sediment, having the most significant influence on land-ocean sediment fluxes[22]. Unregulated sediment mining can impact the bank height and induce instability, "threatening key infrastructure and communities located on the banks of the river", while unregulated and aggressive sediment extraction has the potential to impact flood risk and environmental resilience in the lower region of the extraction sites[23].

Furthermore, another extremely serious concern regarding the Mekong river is water pollution due to different sources of pollution[24]. For instance, the usage of antibiotics[25] and agriculture-related use of pesticides have hazardous contaminating effects on the Mekong River waters. Specifically, monitoring research findings demonstrated "a critical situation of a likelihood of chronic exposure of populations and ecosystem to these pesticides, especially in rural areas where the number of households having access to clean water is limited"[26], with the water of the river being affected by pollution from different sources. In summary, it can be said that high population density and rapid economic development represent significant factors in the

20. Kondolf et al. 2018. Changing Sediment Budget of the Mekong; Nie et al. Rapid Incision of the Mekong River in the Middle Miocene Linked to Monsoonal Precipitation.

21. Hackney et al. 2020. River Bank Instability from Unsustainable Sand Mining in the Lower Mekong River.

22. Fan, He, and Wang. 2015. Environmental Consequences of Damming the Mainstream Lancang-Mekong River.

23. Hackney et al. 2020. River Bank Instability from Unsustainable Sand Mining in the Lower Mekong River.

24. Merola et al. 2015. Arsenic Exposure to Drinking Water in the Mekong Delta; Stuckey et al. 2016. Arsenic Release Metabolically Limited to Permanently Water-Saturated Soil in Mekong Delta; Tran et al. 2020. Hydrogeochemical Characteristics of a Multi-Layered Coastal Aquifer System in the Mekong Delta, Vietnam; Zhang et al. 2019. Health Risk Assessment of Heavy Metals in Cyprinus Carpio (Cyprinidae) from the Upper Mekong River.

25. Andrieu et al. 2015. Ecological Risk Assessment of the Antibiotic Enrofloxacin Applied to Pangasius Catfish Farms in the Mekong Delta, Vietnam.

26. Chau et al. 2015. Pesticide Pollution of Multiple Drinking Water Sources in the Mekong Delta, Vietnam.

loading of anthropogenic pollutants in the river's water, affecting the overall water function and the health of the entire Mekong River ecosystem[27].

Thus, considering that the MRB region has a strong socioeconomic dependence on the Mekong River[28], it is essential to tackle the effects of the multiple human activities that have affected and still affect its flow, chemical composition, and overall status. As aforementioned, ICT can play a pivotal role in supporting the region's sustainable development, representing a changemaker in the passive and active approaches toward environmental-related issues affecting the river. Yet, technology alone is not enough, and the involved stakeholders should work synchronously following a common framework of actions. Accounting for the importance of this, in the rest of this manuscript, we offer a three-pillar model to formally drive the implementation of technology-driven solutions in a mitigation strategy, aiming to prevent, mitigate, or fight against the numerous issues currently affecting the river, and thus supporting the race toward the achievement of the United Nations (UN) SDGs in the MRB region.

METHODOLOGY

This paper represents a review of the current situation in the MRB region in terms of environmental issues, mainly related to dam constructions, in addition to other challenges caused by water pollution and uncontrolled sediment extraction. The paper presents a three-pillar model to address and mitigate these issues to guide a mitigation strategy leveraging ICT affordances. The paper first outlines an overview of the current ecosystem in terms of environmental issues in the MRB region. Then, a three-pillar model is presented, accounting for the affordances that ICT can offer to address these issues. Finally, the conclusions form the final part of the manuscript. The model, which aims to be a simple tool to guide the adoption of mitigation strategies by policymakers and decision makers, is based on theories

27. Sow et al. 2019. An Assessment of Heavy Metals Toxicity in Asian Clam, Corbicula Fluminea, from Mekong River, Pa Sak River, and Lopburi River, Thailand.

28. Wang et al. 2021. Understanding the Impacts of Climate Change and Socio-Economic Development through Food-Energy-Water Nexus.

and applications in other contexts. The relevance of the literature chosen is based on purpose, reliability, and effectiveness. Reports, journal articles, national policies, and national news from reliable sources were included in this manuscript.

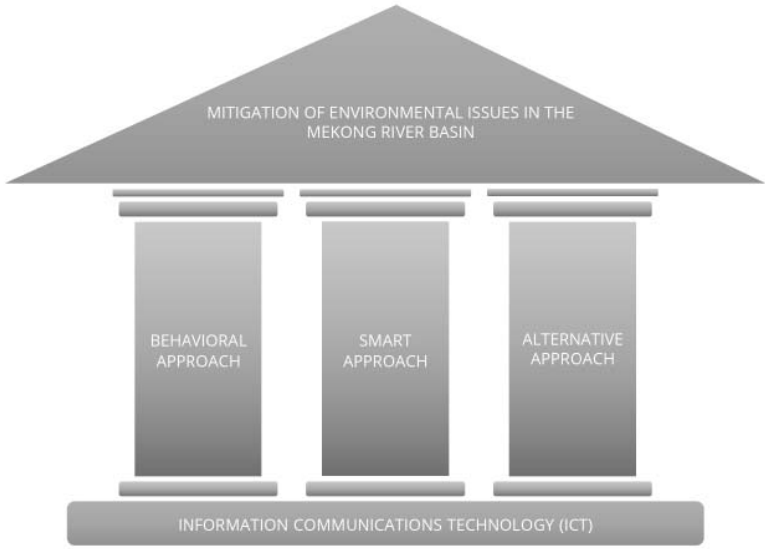
MITIGATION STRATEGY: A THREE-PILLAR MODEL

The Mekong River represents a fundamental element of sustainment for many people in the MRB region[29]. Yet, it is suffering from many human-induced issues, not limited to, but mainly categorisable to, dam-related projects, sediment extraction, and water pollution. As mentioned earlier, information technology (IT) can be a changemaker toward more sustainable usage of the Mekong River but left by itself, it simply represents a tool. This chapter offers a framework of action based on three specific pillars for driving regional change. The three pillars are defined by the following approaches: the behavioural approach, the smart approach, and the alternative energy approach. This model should represent the basis of discussion for the creation of a roadmap for all the involved stakeholders in the MRB in the race toward the achievement of more sustainable usage of the river, and thus fostering the achievement of the SDGs, while leveraging on IT-driven solutions in alignment with the directions outlined in the ASEAN Digital Masterplan 2025[30].

29. Corrado, Liwan, and Korwatanasakul. 2022. Information & Communications Technology Solutions for Environmental Issues in the Greater Mekong Subregion.

30. The ASEAN Secretariat. ASEAN Digital Masterplan 2025.

Figure 1. Three-Pillar Model.



Mitigation Strategy: Behavioural Approach

The theory of change is "a purposeful model of how an initiative, such as a policy, a strategy, a programme, a project or an intervention contributes through a chain of early and intermediate outcomes to the intended result"[31]. This is essential to account for, considering that human behaviour is commonly accepted as one of the significant contributors to environmental issues. The question of how to modify identities and social norms represents a fundamental and central pillar of many theories of change[32]. Considering the broad field of theories of change, there is emerging "an increasing consensus for a need to incorporate individuals within a group learning situation based around the use of feedback loops"[33]. In addition to the simple loop approach, double loop learning has also been proposed, where an individual initially

31. Rad and Rad. 2021. Theory of Change in Digital Behavior Change Interventions (Dbcis) And Community-Based Change Initiatives – A General Framework.

32. Inman et al. 2018. An Exploration of Individual, Social and Material Factors Influencing Water Pollution Mitigation Behaviours within the Farming Community.

33. Inman et al. 2018.

engages in a "first loop" of learning before later passing to a second phase (or loop), where review and scrutinisation of the first phase take place[34]. Specifically, while during the first loop, learning occurs, in the second loop, an individual generates a "completely new way of thinking"[35]. Following this approach, new outlooks, behaviours, identities, and norms are "embedded within the group undertaking the learning process"[36].

Accounting for these theoretical underpinnings, ICT has shown itself to be capable of supporting behavioural change[37]. Specifically, within the theory of change, a specific area of study focuses on digital interventions to change behaviours in individuals or communities through digital tools. Regarding this, digital behaviour change interventions (DBCIs) and community-based change initiatives represent complex designable systems[38] to guide strategic thinking and action[39]. The usage of DBCI is not new, and several cases present in the literature describe its use in different spheres of intervention, like health and health promotion[40], engagement[41], food choice[42], environmen-

34. Inman et al. 2018.

35. Inman et al. 2018.

36. Inman et al. 2018.

37. Rad and Rad. 2021. Theory of Change in Digital Behavior Change Interventions (Dbcis) And Community-Based Change Initiatives – A General Framework.

38. Rad and Rad. 2021.

39. Rad and Rad. 2021.

40. Keller et al. 2022. Digital Behavior Change Interventions for the Prevention and Management of Type 2 Diabetes; Martín-Martín et al. 2021. Behavior Change Techniques and the Effects Associated With Digital Behavior Change Interventions in Sedentary Behavior in the Clinical Population; Perski et al. 2019. Assessing the Psychometric Properties of the Digital Behavior Change Intervention Engagement Scale in Users of an App for Reducing Alcohol Consumption; Perski et al. 2020. A Self-Report Measure of Engagement with Digital Behavior Change Interventions (DBCIs); Stellefson et al. 2020. Evolving Role of Social Media in Health Promotion.

41. Perski et al. 2020. A Self-Report Measure of Engagement with Digital Behavior Change Interventions (DBCIs).

42. Lazzarini, Visschers, and Siegrist. 2018. How to Improve Consumers' Environmental Sustainability Judgements of Foods; Simeone and Scarpato. 2020. Sustainable Consumption.

tal awareness[43], and marketing[44]. Additionally, Farrow et al.[45] reviewed the literature on the impacts of various social norm interventions on pro-environmental behaviours. They pointed out how "these interventions are effective at inducing significant behavioural changes, and that descriptive norms seem to demonstrate particularly consistent effects".

Thus, considering the power of ICT in supporting behavioural changes aiming to foster more environmental-friendly practices at the community level, leveraging on DBCIs for tackling environmental issues should be an essential pillar in the mitigation strategy model to promote sustainable development in the MRB, addressing the behavioural sphere through inducing a behavioural change in the local communities[46].

Mitigation Strategy: Smart Approach

The second pillar of the proposed model for mitigating the Mekong River-related issues focuses on technology, specifically transforming ecosystems into their smart versions. Regarding this, technologies are disrupting many spheres of our lives, representing a possible viable and effective solution to explore and adopt in the MRB region. More specifically, within the technological sphere, stress is placed on ICT and ICT-driven solutions that are currently available and have already proven effective in other contexts[47].

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43. Díaz-Pont et al. 2020. Environmental Communication in the Intertwining of the Local and the Digital; Liwan et al. 2020. Willingness to Pay for Environmental Goods in East Malaysia; Narula et al. 2018. Environmental Awareness and the Role of Social Media; Simeone and Scarpato. 2020. Sustainable Consumption; Tuitjer and Dirksmeier. 2021. Social Media and Perceived Climate Change Efficacy.

44. Alalwan et al. 2017. Social Media in Marketing; Domenico et al. 2021. Fake News, Social Media and Marketing; Jin, Muqaddam, and Ryu. 2019. Instafamous and Social Media Influencer Marketing.

45. Farrow, Grolleau, and Ibanez. 2017. Social Norms and Pro-Environmental Behavior.

46. Farrow, Grolleau, and Ibanez. 2017.

47. Corrado. 2021. ICTs and AI-Driven Solutions for Disaster Management; Corrado, Liwan, and Korwatanasakul. 2022. Information & Communications Technology Solutions for Environmental Issues in the Greater Mekong Subregion; Dwevedi, Krishna, and Kumar. 2018. Environment and Big Data; Janitra. Implementation of Smart City for Building Disaster Resilience in West Java Province; Toma et al. 2019. IoT Solution for Smart Cities' Pollution Monitoring and the Security Challenges.

In the recent past, the world has experienced a digitisation process on a global scale. This ICT-led process is data-driven and has been supported by the digitisation wave that has invested the world as a whole. This process is not new, but it has been exponentially growing in the last fifteen years, due to the increased capacity of calculations, interconnections, and storage of computers, to the point of introducing the word *Zettabyte*[48]. This digitisation process enables another process: the transformation of cities into their smart versions: smart cities[49]. Smart cities are intended as a network of many devices capable of effectively and efficiently creating a network of data-exchanging nodes. Usually, we consider smart cities, assuming that the covered area is an urban area, and thus, the term *smart city*. But the affordance of technologies is not tied to cities or urban areas. Still, it can be implemented in any region if a specific infrastructure allowing efficient communication is present or is deployed. Within the concept of smart cities, or smart environments, we can identify four components: data and technology, physical environment, society, and governance[50].

With the first component, we refer to the idea of technologies and their affordances, together with the ability to manage a huge amount of data to understand a scenario better or even predict what will happen shortly[51]. The second component refers to the physical infrastructures that support smart cities/environments[52]. For example, smart cities rely on effective 4G or even 5G coverage and an effective optical fibre backbone for connecting every point of the considered geographical area, a fundamental element for having a well-connected region capable of offering fast and efficient exchange of data, the essential fuel for ICT-driven solutions. Furthermore, in the last few years, the path toward enhanced connectivity in remote areas has been paved by low Earth orbit (LEO) satellite constellations such as Starlink, OneWeb, Telesat, and the Kuiper project, raising higher expectations on what telecommunication infrastructures can offer in an IoT ecosystem. The

48. Bonderud. 2019. Zipping Past the Zettabyte Era.

49. Janitra. 2020. Implementation of Smart City for Building Disaster Resilience in West Java Province.

50. Janitra. 2020.

51. Janitra. 2020.

52. Corrado. 2021. ICTs and AI-Driven Solutions for Disaster Management;

third aspect relies on society, which refers to the creation of a knowledgeable society capable of knowing how to interact and control, and even develop technological solutions capable of offering an almost endless array of new possibilities[53]. Finally, the last element refers to governance, considered a vector of components including policies and regulations, urban and rural areas management, and public services[54].

The creation of smart regions relies on a wide matrix of different sensors capable of measuring a wide heterogeneity of variables, which are interconnected with a central system and can be used for an enormous array of technology-driven solutions. This idea is currently being investigated in many areas of applied technology to environmental protection. For instance, Jamil et al.[55] discussed the possibility of using public transportation to collect data regarding air pollution in cities so that a monitoring process could be available for pollution control and planning timely actions. A similar approach was discussed by Dwevedi et al.[56] for the Indian context and by Toma et al. (2019). They introduced the idea of using pollution data collected by sensors placed on traffic lights to redirect traffic or close specific streets to continuously address and tackle the hazardous pollution levels in particular city areas. Garzon et al.[57] introduced a context-aware air pollution monitoring and alert service capable of proactively notifying citizens via mobile devices about air quality. Similar approaches have also been followed for monitoring water pollution in different ecosystems[58], relying on IoT solutions.

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53. Janitra. 2020. Implementation of Smart City for Building Disaster Resilience in West Java Province.

54. Corrado and Hill. 2021. Strategy and Barriers to Overcome for Cambodian E-Government: A Discussion Paper; Corrado and Tungjan. 2019. How Digital Tech Can Help Fix Cambodia's Broken Education and Healthcare Systems; Janitra. 2020. Implementation of Smart City for Building Disaster Resilience in West Java Province.

55. Jamil et al. 2015. Smart Environment Monitoring System by Employing Wireless Sensor Networks on Vehicles for Pollution Free Smart Cities.

56. Dwevedi et al. 2018. Environment and Big Data: Role in Smart Cities of India.

57. Garzon et al. 2018. Urban Air Pollution Alert Service for Smart Cities.

58. Agarwal et al. 2018. Design and Development of Air and Water Pollution Quality Monitoring Using IoT and Quadcopter; Moparthi, Mukesh, and Sagar. 2018. Water Quality Monitoring System Using IOT; Shafi et al. 2018. Surface Water Pollution Detection Using Internet of Things.

But pollution is not the only issue that can be tackled with the usage of ICT. Flood management can rely on a wide array of sensors connected and capable of providing a central system the chance to analyse and use the obtained data for various purposes[59]. In this regard, Arepalli et al.[60] proposed a spatial disaster management framework focusing on the issue of flood management, relying on IoT, in addition to the proposed solution by Rothkrantz[61], for the city of Prague, which is at serious risk of flooding due to the Moldau River. Further monitoring solutions based on a network of sensors for river monitoring were also offered for the city of Dublin[62]. In general, data collected by sensors can allow the identification of abnormal patterns in the data, thus allowing the estimation of the probability of extreme phenomena happening, similar to the solutions already adopted in Japan by the Japan Meteorological Agency, in Europe within the Urban-Flood project, and also in Canada.

But, if the solutions offered by ICT are numerous, with a wide variety of applications that can directly interest the MRB region, from the perspective of smart regions, standardisation is a fundamental step to take for dealing with heterogeneity issues among the interaction of cross-domain related stakeholders[63]. As aforementioned, the concept of smart cities, and in general, smart regions, for supporting water flow management, river bed sediments monitoring and regulations, and pollution control rests on several factors, including the involvement of sensors deployment, the centralisation of data, the use of standardisation of data formats, and a well-structured collaboration between different bodies and domains capable of working in a synchronised way toward responding promptly and effectively to critical situations[64]. This represents a massive wave of sensors deployment allowing

59. Melo, Silva, and Macedo. 2016. Flood Monitoring in Smart Cities Based on Fuzzy Logic about Urban Open Data.

60. Arepalli et al. 2019. A Spatial Disaster Management Framework for Smart Cities—A Case Study of Amaravati City—Flood Management.

61. Rothkrantz. 2016. Flood Control of the Smart City Prague.

62. Guibene et al. 2017. Evaluation of LPWAN Technologies for Smart Cities.

63. Nurwatik and Hong. 2019. A Framework.

64. Nurwatik and Hong. 2019.

the mapping and connection of entire regions, something an individual body cannot achieve.

Considering the heterogeneity of the data to measure and the importance of standards to follow for the implementation of the sensors, it can be said that the creation of an effective ICT infrastructure, the foundation of a smart approach, represents a complex project which can be carried out only with the adoption of a common framework capable of offering standard guidelines. These guidelines would offer the capability to highlight the right path to obtain data stored and accessed in a federated way, thus usable cross-agencies across nations.

Mitigation Strategy: Alternative Energy Approach

The last important pillar to consider for a mitigation strategy focuses on alternative energy and renewable sources. The increased fossil fuel usage worldwide in the past several decades is the primary cause of greenhouse gas (GHG) emissions, heavily impacting climate change. China, the United States, the European Union, and India are the largest CO2 emitters in the world[65]. The diversification of energy supply "through investments in renewable energy, coupled with improvements in energy efficiency, offers a viable option to expand the energy system and simultaneously realise substantial socioeconomic and environmental benefits"[66]. In addition to reducing GHG emissions, renewable energy systems can be set up in small units and is therefore suitable for community management and ownership since, unlike nuclear and fossil fuels plants, they do not belong to big companies, governments, or state-owned enterprises[67]. On the other hand, the high initial cost and the more intermittent supply nature[68], compared to traditional fossil en-

65. Chandel et al. 2016. Overview of the Initiatives in Renewable Energy Sector under the National Action Plan on Climate Change in India.

66. Nagpal and Hawila. 2018. Renewable Energy Market Analysis: Southeast Asia.

67. Oyedepo. 2012. Energy and Sustainable Development in Nigeria.

68. al Irsyad, Halog, and Nepal. 2019. Renewable Energy Projections for Climate Change Mitigation; Elum and Momodu. 2017. Climate Change Mitigation and Renewable Energy for Sustainable Development in Nigeria.

ergy, result in the renewable energy industry requiring lots of funds to be invested in research and development, which may represent an initial barrier.

Considering the opportunities offered by renewable energy sources, it is essential to explore the different feasible solutions for adopting effective alternative renewable energy sources, including hydropower, bioenergy, thermal, geothermal, wind, photochemical, photoelectric, tidal, wave, and solar energy[69]. The latter one, namely solar energy, is currently the most promising renewable energy source for meeting emission reduction targets in the electricity sector[70]. In the specific, Photovoltaics (PV) has lately become the "dominant technology to tap the solar potential for electricity generation", and this is proven by how solar energy has become the technology with the highest growth rate among renewable energy technologies[71]. Additionally, regarding PV, Creutzig et al.[72] estimated that by 2050, "PV could optimally generate 67–130 EJ of electricity and thus be the dominant electricity supply technology with a share of 30–50% in electricity generation even as the energy system will become more electricity intensive than today's".

In general, independently from the typology of the source, it can be said that energy-related technological innovation is "an important way to achieve energy conservation and emission reduction"[73]. Considering the opportunities offered by renewable energy sources is a fundamental step since, currently, the energy sector is the largest source of GHG emissions, with the estimated total amount of energy-related emission forecasted to increase by about 16 per cent by 2040[74]. Regarding this, only accounting for Southeast Asia, regional energy consumption nearly doubled between 1995 and 2015,

69. Elum and Momodu. 2017. Climate Change Mitigation and Renewable Energy for Sustainable Development in Nigeria.

70. al Irsyad, Halog, and Nepal. 2019. Renewable Energy Projections for Climate Change Mitigation.

71. Creutzig et al. 2017. The Underestimated Potential of Solar Energy to Mitigate Climate Change.

72. Creutzig et al. 2017.

73. Lin and Zhu. 2019. The Role of Renewable Energy Technological Innovation on Climate Change: Empirical Evidence from China.

74. Elum and Momodu. 2017. Climate Change Mitigation and Renewable Energy for Sustainable Development in Nigeria.

with an average annual growth of 3.4 per cent[75]. Fossil fuels, driven by mainly oil and natural gas, "account for more than half of the region's energy supply", with crude oil and its derivatives being "predominantly used in the transport sector, where fuel demand has grown rapidly"[76].

To shift away from this heavy dependency on fossil fuels, all ten ASEAN members have already set national renewable energy targets and agreed to aim for the goal of 23 per cent usage of "renewables in their total primary energy supply (including large-scale hydropower but excluding traditional biomass) by 2025"[77], with Indonesia, Malaysia, the Philippines, Thailand, and Vietnam being "comparatively more advanced in the region in terms of policy maturity and comprehensiveness"[78]. Some examples of green energy solutions in the region are represented by the Thai developer Green Earth Power, which in 2014 signed an agreement with the Myanmar government to develop a 220 MW solar project[79], and in Vietnam, the Danish manufacturer Vestas Wind Systems that together with the indigenous firm Phu Cuong Group have signed a memorandum of understanding for the construction of a 170 MW wind farm[80].

But shifting from traditional energy sources to renewable ones in the whole region is not easy, particularly in a highly non-homogenous ecosystem like ASEAN[81]. Nevertheless, renewable energies represent a fundamental pillar for the model due to the importance of shifting from non-renewable to renewable sources of energy, a goal set at the international stage, as well as at the ASEAN one, while accounting for the current intraregional economic disparity[82], and for the non-homogeneity of human development, an essential component necessary to support and maintain the infrastructure behind alternative sources of energy. In fact, following the UNDP taxono-

75. Nagpal and Hawila. 2018. Renewable Energy Market Analysis.

76. Nagpal and Hawila. 2018.

77. Nagpal and Hawila. 2018.

78. Nagpal and Hawila. 2018.

79. Sen and Ganguly. 2017. Opportunities, Barriers and Issues with Renewable Energy Development – A Discussion.

80. Sen and Ganguly. 2017.

81. Corrado and Liwan. 2021. E-Learning.

82. Ishikawa. 2021. The ASEAN Economic Community and ASEAN Economic Integration.

my[83], Singapore, Malaysia, and Brunei Darussalam were classified as countries of "Very High Human Development"; Thailand, Vietnam, Indonesia, and the Philippines as "High Human Development" countries; and Cambodia, Myanmar, and the Lao PDR as countries of "Medium Human Development". Accounting for this diversity within ASEAN, the creation of regional policies emerges as an essential aspect for addressing economic growth, education and training, research and development, and in general, the broader national investments[84] with a focus on green energy production.

CONCLUSIONS

The Mekong River represents a vital element for the economic sustainment and prosperity of the MRB region. Unfortunately, due to human-driven activities related to fishery activities, agriculture, industrial processes, and energy production, the river has experienced a severe environmental downturn. In this paper, we proposed a model based on three pillars, namely the behavioural approach, the smart approach, and the alternative energy approach, to adopt for environmental issues mitigation in the MRB region. An overall framework of action, with clear goals and guidelines, should be agreed upon by the involved countries, enabling the adoption of ICT-driven solutions to be a changemaker in the process of implementation, action, monitoring, and evaluation of several environmental issues currently affecting the MRB region. In this paper, we highlighted how ICT can play a vital role in fostering sustainable development in the region if only all the countries part of the MRB region, united by the dependence on the Mekong River, define a roadmap that may be initiated from the proposed model.

83. UN. 2019. Human Development Index.

84. Nagpal and Hawila. 2018. Renewable Energy Market Analysis.

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