An Approach to Spatial Variations and Resilience of Small Island Sustainability: A Case Study of Kiribati

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Abstract: Small island states are regarded as the poster children in the resilience of global climate change, while their sustainability varies within individual states considering the complicated interactions of spatially differentiated environmental, economic, and social factors. As the typical case of sea-locked scattering atolls, Kiribati shows its dramatic sustainability variations in different spatial scales. The findings of place-specified questionnaires from Kiribati citizens show that local perspectives on sustainability vary among urban areas, rural areas, as well as remote island areas. The results of the research hopefully provide policy implications for space-specific small island sustainability resilience.

1. Introduction
The global tensions between environmental changes and human development are upgrading in recent years, and worldwide research practices are boosting the emerging of the trans-disciplinary new ‘science of the Earth’ in “understanding the structure and functioning of the Earth as a complex, adaptive system” (Steffen et al., 2020). Under the situation of a more integrated global economy, small islands, owing to the limited natural resource and land territories, are generally venerable to similar threats compared with the continental areas. The “global, regional economic, and environmental change processes often have disproportionate and inequitable impacts on small island communities” (Lowitt, Saint Ville, Lewis, & Hickey, 2015). A typical case will be the tempo-spatial scale of El Niño-Southern Oscillation (ENSO) cycle, which impacts are far beyond the adaptation capability of Small Island Developing States (SIDS) (Kelman, 2019).

Small Island Developing States differ in the vulnerabilities caused by climate and non-climate in different marine regions. The regional factors of geophysical, economic, and social conditions contribute to the diversified capabilities of sustainable development adaptations models (Robinson, 2019). SIDS are regarded as the poster children of global climate change research. Their territorial and geographical specified conditions, such as asymmetrical governance structures, archipelagic center-periphery relationships, as well as intra- and inter-island movements, should be addressed among other general factors (Petzold and Ratter, 2019). The sustainability limitation of one small island state appears not only in its central area, such as urban recycling issues in the Viti Levu Island of Fiji (Nunn et al., 2019), but also in remote rural communities when facing difficulties in resilience of shocks and global changes, such as the global economy impacts and natural disasters in Solomon Islands (Schwarz, et al 2011). Compared with the suffering of the island issues, the problems of governing the much larger marine commons, such as Palau’s marine protected area, are far more difficult (Gruby and Basurto, 2014).

The Sustainability Assessment by Fuzzy Evaluation (SAFE) model is regarded as one of suitable methods in approaching sustainability performances in the cases of lacking exact database (Phillis and Andriantiahsaholiniaina, 2001). The SAFE model combines two primary components of ecological...
sustainability (ECOS) and societal or human sustainability (HUMS) into the overall sustainability (OSUS) assessment system (Phillis, Grigoroudis, and Kouikoglou, 2011). Less academic reports focus on the spatial variations of scattered regions such as small islands. In one of the author’s co-authored conference paper, the research of applying SAFE model into Pacific SIDS shows spatial dynamic variations in SAFE indicators in the level of a group of state members (Liu, Shang, and Liu, 2019).

As the typical case of sea-locked small island state, Kiribati has been studied in respect to sustainability in recent decays. Global warming and associated sea-level rise have threatened the major atoll of Kiribati’s Tarawa and generated further problems in the capital city’s urbanization (Storey and Hunter, 2010). Along with the urban areas’ infections, the anticipated sea-level rise has brought about widespread bank erosion which conflicts with human daily activities at different coastal areas of the major atoll (Biribo and Woodroffe, 2013; Babinard, Bennett, Hatziolos, Faiz, & Somani, 2014). As the resilience of the climate change induced damages, the domestic economic strength such as the Sovereign Wealth Funds (SWF) of Kiribati is essential, but not enough, in reducing overseas aid for ex-post disaster risk management (Taupo, 2019). Education of scattered populations is essential for local resilience toward sustainability, but there are also ownership issues in foreign aid and inclusive education (Yates, Carrington, Gillett-Swan & Pillay, 2019).

The purpose of this paper is to probe into the spatial performances of sustainability variations within individual island state. The research attempts to expand the ways of formulating place-specific policies in order to make precise and flexible resilience decisions for both international stakeholders and the island states’ own national policymakers.

2. Objectives and Methods

Kiribati has a large spatial span and the natural environment has obvious differences. Located in the central Pacific Ocean, Kiribati comprises 33 coral atolls that across both the equator and the International Date Line, and is the only country that situated within all four hemispheres (International Renewable Energy Agency, 2017). It possesses over 3.5 million square kilometers of open ocean and the Phoenix Islands of Kiribati possesses the second largest marine protected area (MPA) in the Pacific Ocean hemispheres (International Renewable Energy Agency, 2017). The environmental and climatic vulnerability are the primary concerns of island energy hemispheres (International Renewable Energy Agency, 2017).

The indicators supporting Kiribati sustainability questionnaire are re-designed concerning the revised SAFE model shown in Figure 1, with bias of place identifications for spatial variation analysis. The survey gathered information of the demographic characteristics (age and sex), households location (urban, town, or remote island), local business type, perceptions/attitudes of local sustainability issues, perspectives that are needed to be improved, stake-holders that can help to improve the resilience of climate change, important foreign country partnership, and open comments/suggestions.

![Figure 1. Revised SAFE model for Small Island Sustainability survey](image-url)
Considering the availability of Kiribati citizens who would like to accept the online survey and cope with in-depth interviewing, the questionnaires designed in two versions, Word version distributed via Email as well as online survey link distributed via social apps, were distributed to Kiribati economics major undergraduate students in Ocean University of China (OUC). In order to specify regional variations of the sustainability characters within the areas of Kiribati, the questionnaires increased the place specification terms for further analysis (Figure 2).

![Distribution of interviewees of the sampling Survey in Kiribati](Map adapted from: Government of Kiribati (2019))

### Figure 2. Distribution of interviewees of the sampling Survey in Kiribati

3. **Results of The Survey**

During several rounds of online communications with the interviewees, the thirteen effective questionnaires are collected and processed for analysis. Seven questionnaires are in Word version, and four questionnaires are in online version. In the collected questionnaires, 9 are from urban areas while 4 are from rural areas. The main results survey results of the interview are shown in Table 1 and 2 as follows.

| Table 1. Local sustainability survey results of Kiribati (a): Open questions |
|---------------------------------------------------------------|
| **Aspects** | **Urban region reflects** | **Rural region reflects** |
|---|---|---|
| Aspects that Improve Sustainability | Regulations to the public on harvesting marine resources; Investment on industries; Disaster aids; Foreign labor recruitment; Help building maritime as well as green projects; Help marketing local handicrafts; Offer more labor work opportunities; | Building a strong relationship with other country in order to have better chance to sustainability; Offering more scholarships and overseas labor service; Providing helping funds and offering work for Kiribati peoples. |
| Aspects that Harm Sustainability | Investment on infrastructure; Overfishing; Big-scale aids that hurt local sustainability; Infringe of domestic governance. | Climate change and induced sea level rise in Kiribati; Exporting of unwanted or contaminating goods to Kiribati; Deforestation activities in Kiribati. |
Table 2. Local sustainability survey results of Kiribati (b): multiple answer questions

| Indicator category | Major factors | Urban region reflects | Rural region reflects |
|--------------------|---------------|-----------------------|-----------------------|
| ECOS Aspect        | Climate change resilience | Local preparedness (6) | Foreign aid (4) |
|                    |                | Protection for venerable people (6) | Local preparedness (4) |
|                    |                | Foreign aid (5) | Government policies advancing (3) |
|                    |                | Government policies advancing (4) | Protection for venerable people (3) |
|                    |                | NGO funding (3) | NGO funding (2) |
| Marine and coastal sustainability | Preserve fishery stock (7) | Establish resource protected area (3) | |
|                    |                | Establish resource protected area (6) | EEZ spatial planning (2) |
|                    |                | Improve fishing skills (2) | Preserve fishery stock (2) |
|                    |                | EEZ spatial planning (1) | Improve fishing skills (1) |
|                    |                | Not clear (0) | Not clear (1) |
| HUMANS Aspect      | Social problems | Lack of sanitation conditions (5) | Low income (4) |
|                    |                | Low income (3) | Food securities (3) |
|                    |                | Less quality drinking water (3) | Less quality drinking water (2) |
|                    |                | Housing or room renting cost (2) | Housing or room renting cost (1) |
|                    |                | Food securities (2) | Lack of sanitation conditions (1) |
|                    | Better society life | More free trade and investment (5) | More free trade and investment (3) |
|                    |                | Sufficient government operation (4) | Sufficient government operation (3) |
|                    |                | Strong foreign aid (4) | Strong foreign aid (3) |
|                    |                | Neighborhood maritime state organization effort (3) | Neighborhood maritime state organization effort (2) |
|                    |                | Migration out to other places (2) | Migration out to other places (1) |
| International sustainability partnership | Australia (7) | New Zealand (4) | |
|                    | China (7) | China (3) | |
|                    | New Zealand (7) | Maritime island states neighbors (2) | |
|                    | USA (5) | Australia (2) | |
|                    | UK (3) | France (1) | |
|                    | Japan (2) | Japan (1) | |
|                    | Maritime island states neighbors (1) | Korea (1) | |
|                    | France (1) | UK (1) | |
|                    | Korea (1) | USA (1) | |
| International sustainability effort | Trade of goods and service (9) | Trade of goods and service (4) | |
|                    | Education and training of citizens (7) | Education and training of citizens (3) | |
|                    | Aid in medical care and sanitary conditions (7) | Aid in medical care and sanitary conditions (3) | |
|                    | Help in marine spatial planning (4) | Help in marine spatial planning (2) | |
|                    | Help in migration (3) | Help in migration (0) | |
|                    | Investment in infrastructure and industries (2) | | 

4. Summary of Regional Variations of Kiribati Sustainability Survey

Through categorizing the survey’s feedback into urban and rural reflects shown in Table 1 and 2, the spatially varied features of the Kiribati sustainability could be summarized as:

1. Open questions: urban citizens stress the endogenous sustainable development capability building initiatives; rural citizens prefer to keep good relations with international sustainability partners. As for actions that should be avoided or refused, the urban citizens stress that Kiribati should refuse over & random aids, big constructions, and overfishing; the rural citizens stress reducing harms from climate-induced sea-level rise, deforestation, and unwanted imports.

2. Climate change adaptation: the urban citizens seem to be more positive in reinforcing endogenous adaptations of climate changes, while the rural citizens stress international partners’ help
such foreign aid;

3. Marine resource sustainability: the urban citizens stress more about resource reserve and marine area protection, while the rural citizens, or more accurately, the coastal rural citizens argue additional importance of marine spatial planning;

4. Economic strength: not like the general knowledge of urban economies, the urban area businesses of Kiribati focus on fisheries and crops growing other than normally acknowledged services, while the tourism industries appear to be rural area’s business choice instead of in urban areas. The regional division of urban-rural industries seems to be obscure in the limited atoll sphere;

5. Social resilience: in addition to other normal social problems of undeveloped societies, the Kiribati urban area sanitation conditions are worrisome comparing to rural areas, where the low-income families are most obvious. As for ways of improving social life quality, the urban citizens prefer international trade and investment, whereas the rural citizen stress more about foreign aids;

6. International sustainable partnership: the urban citizens have a larger range of choices and prefer global major economics with less consideration of their geographical remoteness. The rural citizens prefer geographical vicinity economics as well as maritime close neighbors. As for the contents of international partnership, the urban and rural citizens have similar feedback as shown in Table 1. The slight differences remain in that urban citizens prefer help in marine spatial planning and migration, while the rural citizens stress infrastructure investment;

5. Assessments on The Spatially Varied Sustainability

Based on the SAFE indicator establishment logic, the survey results assessment methods develop from commonly applied scoring procedures for small island sustainability (Van Beynen, Akiwumi, and Van Beynen, 2018). In pursuit of scoring clarity, the general scoring of ECOS and HUMANS are further divided into ECOS, HUAMNS-1, and HUMANS-2 in coping with the questions and answers during the survey. Along with that, each indicator is broken into two dimensions of level and scope. In securing the credibility of scoring, five sustainability professionals in marine spatial sustainability fields are interviewed for the improvement of scoring. In order to further present the possible differences within the general categorized rural citizens, the scoring breaks the category into rural town citizens and rural remote island citizens. From urban to town and to remote islands, the sustainability performances scoring reflects the major interesting features as in the scatter plot charts (Figure 3):

![Figure 3. Scatter plot of location identified sustainability assessment of Kiribati](image-url)

1. The ecological aspect’s sustainability performances are wider in gaps in terms of both levels and scopes. The urban citizens’ feedback shows a little bit better understanding of resilience of sustainability than that of the town and remote island residents.

2. The economic aspect’s sustainability performances are concentrated with each other but with a
lower average level compared to ECOS appearance. The remote island settlers seem to be confined to economic development traps than the other two groups.

3. The social aspect's sustainability performances are majorly lower than ECOS and HUMANS in levels. The more distant from the location to capitals, the worse the social development capabilities.

In order to visualize the regional sustainability perception variations of the interviewees, the maps of three scales, the whole state map, the map of major islands, as well as the map with the capital city, are presented (Figure 2). The three categories of urban, town, and remote island sampled citizens are marked based on the locations of their household addresses. Through the expression of sustainability performances, the level and scope gaps among regionally varied sustainability could be partially explained through differentiated geographical conditions.

6. Conclusion
The sustainability of small islands is of importance in both academic research and actual decision-making processes. The spatial diversification of geographical conditions, humanistic endowments, as well as international partnerships interactions, drive the small islands sustainability issues into the manifestos of regional differentiation.

The case study of Kiribati, the typical scattered small islands state with the second largest marine spaces in the Pacific region, helps to reinforce the conclusion above. Comparing to their small island neighbors, Kiribati citizens prefer keeping and steadying international partnerships with strong but remote states, while partial citizens prefer to establish and maintain partnerships with maritime neighboring countries. These will help us focus all partners’ endowments including the individual member, the remote but strong partners, as well as the adjacent neighbors.

The expected sustainability of Kiribati regionally varies in major indicator levels and scopes. The citizens living in relatively urbanized areas care more about environmental sanitation and positive international sustainability partnerships. They also refuse to over-fishing, over aid, and increase external reliance. While the citizens in rural towns and isolated atolls primarily need safeguarding local living basics of income security, food provision, defense of sea-level rise, as well as protection of their fishing stocks. Not like the urban interviewees who strongly opposite big construction and huge investment, the rural representatives seem to be more eager to attract investment and obtain foreign aids. The facts of local-level variation of sustainability resilience show the importance of considering place-specific countermeasures for policymakers.

7. Acknowledgement
The author sincerely thanks Ms. Yingshi Shang, one of the earlier conference paper co-author in the AAG 2019 meeting, Ms. Yawen Kong, who helped in designing and collecting online questionnaires, and most importantly, the interviewees of the questionnaires.

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