Marine Information Systems: Reality and Visions of Augmented Reality

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Key words: Marine Information System; Marine Cadastre; Marine Spatial Data Infradtructure; Marine Spatial Planning; Blue Economy; Augmented Reality.

SUMMARY

According to NOAA (2016) oceans contribute more than US$280 billion to the USA's Gross Domestic Product (GDP), and impacts more than 2.8 million jobs with ocean mineral extraction, tourism and recreation accounting for approximately seventy percent of oceans economy's GDP. Worldwide, in 2012, an estimated 58.3 million persons were engaged in the fisheries industry (FAO 2014). Internationally, and apart from tourism, recreation, the transportation of consumer goods, fisheries and aquaculture, the importance of oceans is represented by economic potentials linked to marine bio-prospecting, non-renewable and renewable energy among other things (United Nations 2014). The importance of ocean economies, combined with multiple users having multiple and often overlapping rights and objectives, has spawned concepts such as Marine Spatial Planning (MSP). MSP seeks to provide integrated and structured governance frameworks that facilitate collaborative or coordinated informed decisions among multiple users including those from government, the energy sector, conservation stakeholders among others. MSP therefore implies the sharing of information among stakeholders, and therefore the need for appropriate marine spatial information systems and standards to serve multiple purposes and objectives, and to support informed decision making. In these scenarios, concepts such as marine cadastres and Marine Spatial Data Infrastructures (MSDI) become relevant.

Augmented reality applied to marine spaces could assist MSP through the provision of additional information to persons moving through those spaces. The additional information could come from marine cadastres operating in MSDI environments. Discussions in this regard is useful, even if the reality of developments (in terms of implementations) in marine cadastres and MSDI remain at the conceptual stages in most jurisdictions, especially in Small Island Developing States (SIDS), because there is much competition for limited national financial resources and no crisis has yet been directly tied to the lack of these systems.

The paper reviews case studies where instances of the creation of undesirable overlapping rights in marine environments were discovered, within the context of how augmented reality could have prevented, or highlighted, these situations. Discussions include the current realities of marine cadastre and MSDI in Trinidad and Tobago, as well as the pros and cons of investing in these systems despite the reality of economic constraints. The arguments relate to policy/regulation conformity with regard to MSP or other marine/maritime management frameworks.

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1. INTRODUCTION

Many sources agree that the oceans contribute significantly to nations' annual Gross Domestic Product (GDP). In a large economy such as that in the United States of America (USA), the 2016 estimate of the oceans contribution to GDP was more than US$280 billion, and oceans impacted more than 2.8 million jobs relating to ocean mineral extraction, tourism and recreation that accounted for approximately 75% of the country's oceans economy's GDP [NOAA 2016]. In 2012, an estimated 58.3 million persons worldwide were engaged in the fisheries industry [FAO 2014]. In Europe, marine and maritime contributions to GDP of the European Union (EU) comes from [Eurostat 2016]:

- Wholesale and retail trade, transport, accommodation and food service activities;
- Public administration, defence, education, human health and social work activities; and
- Industry (except construction).

Internationally, and apart from tourism, recreation, the transportation of consumer goods, fisheries and aquaculture, the importance of oceans is represented by economic potentials linked to marine bio-prospecting, non-renewable and renewable energy among other things [United Nations 2014].

The economic importance of oceans and, as well, the fact that there are multiple users having multiple and often overlapping rights and objectives, have underscored the development of concepts such as Marine Spatial Planning (MSP) [UNESCO IOC 2009; Blæsbjerg 2009]. MSP seeks to provide integrated and structured governance frameworks that facilitate collaborative or coordinated informed decisions among multiple users including those from government, the energy sector, conservation stakeholders among others. Specifically, MSP seeks to [UNESCO IOC 2009]:

- Support visions of what is possible in marine areas;
- Protect nature, including reducing the fragmentation of marine habitats;
- Ensure efficient and sustainable use of marine resources;
- Prioritise marine management development objectives;
- Create and stimulate opportunities for new users of marine areas;
- Coordinate and control actions and investments in marine spaces;
- Avoid duplication of effort by different public agencies and levels of government in MSP activities, including planning, monitoring, and permitting; and
- Achieve a higher quality of service at all levels of government through streamlined control of human activities in marine spaces.

MSP implies controlling behaviours in marine spaces according to defined management objectives. Achievement of this type of control requires stakeholders' conformity to MSP policies and regulations etc. Stakeholders (i.e., MSP managers and administrators, and as well public and private users of marine spaces under control) must therefore have access to relevant information. In these scenarios, concepts and systems such as marine cadastres and other marine/maritime information systems become relevant [Athanasiou and Dimopoulou 2016; National Oceanic and Atmospheric Administration 2016; Canadian Hydrographic Service & Geoscience Australia 2016; Sutherland and Nichols 2009; Sutherland and Nichols 2006; Commonwealth of Australia 2009].

MSP also implies the sharing of information among stakeholders, and therefore the need for appropriate marine spatial information systems and standards to serve multiple purposes and objectives, and to support informed decision making. In these scenarios, concepts such as Marine Spatial Data Infrastructures (MSDI) or Marine Geospatial Data Infrastructure (MGDI) become relevant [Peyton et al. 2016; IHB 2009; Canadian Centre for Marine Communications 1999].

The information systems that support (or could support) MSP decision making, or that relevant to other marine/maritime space management paradigms, generally at present provide information about marine spaces whether or not one is actually in those spaces. Database Management Systems (DBMS) structures provide the spatial and attribute information of concern in relation to marine/maritime spatial objects of concern. No one can reasonably deny that this paradigm is useful. However, systems that utilize Augmented Reality (AR) sub-systems can also be useful by providing relevant information to stakeholders while they are moving through physical environments [Bostanci et al. 2017; Carrera and Asensio 2017]. This utility can especially be relevant to marine spaces where written or graphical information cannot easily be placed in those environments.

The paper reviews case studies where instances of the creation of undesirable overlapping rights in marine environments were discovered, within the context of how AR could have prevented, or highlighted, these situations. Discussions include the current realities of marine cadastre and MSDI in Trinidad and Tobago, as well as the pros and cons of investing in these systems despite the reality of economic constraints. The paper proffers a theoretical conceptual vision of how AR can be (or could have been) incorporated into these systems to enhance stakeholder information access, as well as their policy/regulation conformity in relation to MSP or other marine/maritime management frameworks.

2. AUGMENTED REALITY

According to TechTarget (2017) ”Augmented reality is the integration of digital information with the user's environment in real time. Unlike virtual reality, which creates a totally artificial environment, augmented reality uses the existing environment and overlays new information on top of it”. TechTarget (2017) further describes systems, such as AR 3D viewers and AR browsers, that can ” allow users to place life-size 3D models in your environment with or without the use of trackers” and ” enrich your camera display with contextual information” respectively. Devices such as mobile devices, computers and connected tevisions, and head mounted displays, glasses, and lenses can all be used in AR systems [TechTarget 2017].

In the literature, AR has been theoretically applied to many disciplines, including implied spatial information management [Bostanci et al. 2017; Carrera and Asensio 2017]. Figures 1 and 2 show an application of AR involving a map [Unknown 2013]. Figure 3 shows a document overlaid upon ”reality” *via* video and the use of Microsoft HoloLens. Figure 4 shows an AR football line via television. There is no reason to doubt that with the right technologies marine cadastres or other marine information systems could make use of AR to produce augmented information (such as boundaries) that are beneficial to stakeholders moving through marine spaces.

Figure 1: Augmented Reality Demo (a) (Unknown 2013)

Figure 2: Augmented Reality Demo (b) (Unknown 2013)

Figure 3: Augmented Reality Demo - Microsoft HoloLens Review (Mackie 2016)

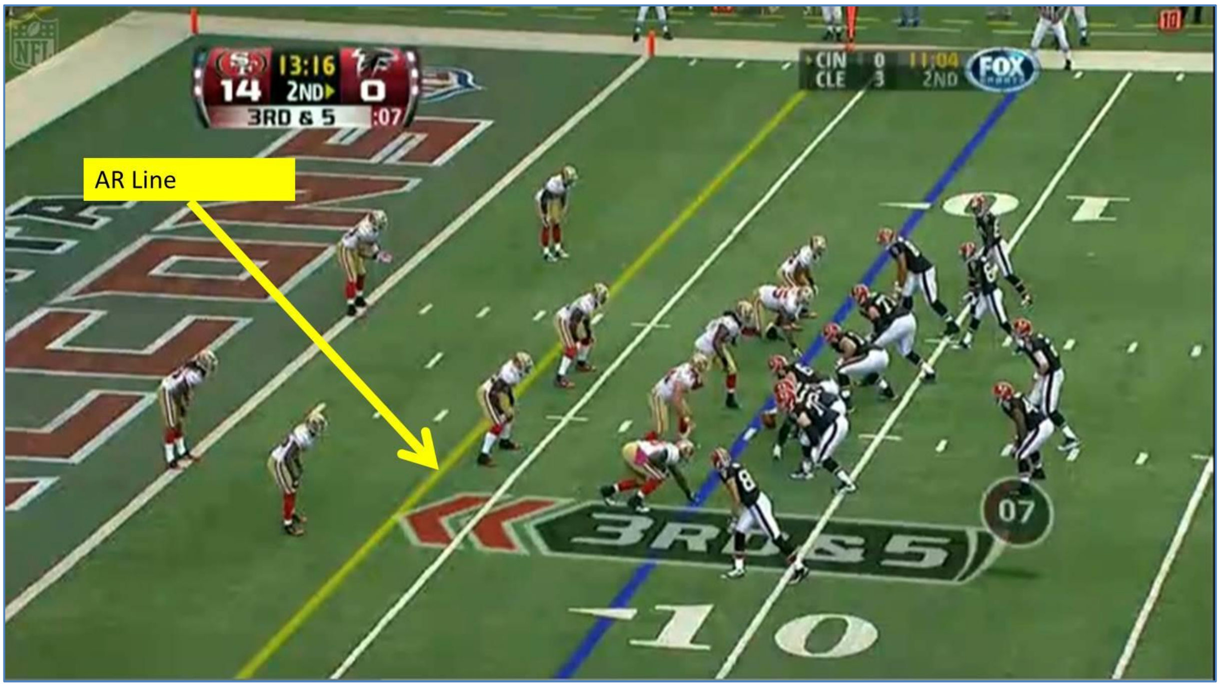

Figure 4: Augmented Reality Football Line (Fischer 2015)

3. UNDESIRABLE OVERLAPPING RIGHTS (MARINE CADASTRE EXAMPLES)

This section reviews two case studies were undesirable or critical overlapping rights were discovered in the process of investigating developments in marine cadastres. The purpose of the discussions is to underscore how AR could have been (or could be useful) to stakeholders moving through marine spaces. Although AR systems were discussed as far back as 1997 [Koller et al. 1997], one has to view the proceeding cases through the lens of what technologies were know or available to users, to be fair.

3.1 Prototype Marine Cadastre for St Margaret's Bay, Nova Scotia, Canada

In 2010 a research group from the Department of Geodesy and Geomatics Engineering, University of New Brunswick, Canada developed a prototype marine cadastre for for St Margaret's Bay, Nova Scotia, Canada. One concept underlying the development of the prototype was the realization that "all rights explicitly or implicitly relate to boundaries, whether these boundaries are clearly defined or fuzzy, and these boundaries have attached to them laws, rules, regulations, restrictions and responsibilities that define acceptable behaviour in these spaces" [Sutherland and Nichols 2010; Sutherland and Nichols 2009] and that the management of boundary information directly supports good governance of marine spaces [Sutherland 2005].

The prototype was developed as a Web Mapping tool using ESRI's ArcServer and populated with Canadian national and provincial datasets. It was discovered that there were marine areas off the coast of St Margaret's Bay that were reserved for the Department of National Defence Canada (DND) (see Figure 5). This was at that time previously unknown to some Nova Scotia provincial authorities, who had made decisions for other use (marine aquaculture) of those spaces.

The situation described above has MSDI/MGDI implications in that there were obviously no framework for institutional relationships and data sharing between the provincial authorities responsible for leasing marine spaces for private aquaculture enterprises, and the DND, even though both entities clearly had interests in the same marine space. While an MSDI/MGDI framework would have minimized the administrative ignorance, AR systems incorporated into the scenario could have alerted public and private users moving through those spaces that they were traversing sensitive DND areas (with for example, graphic boundary information).

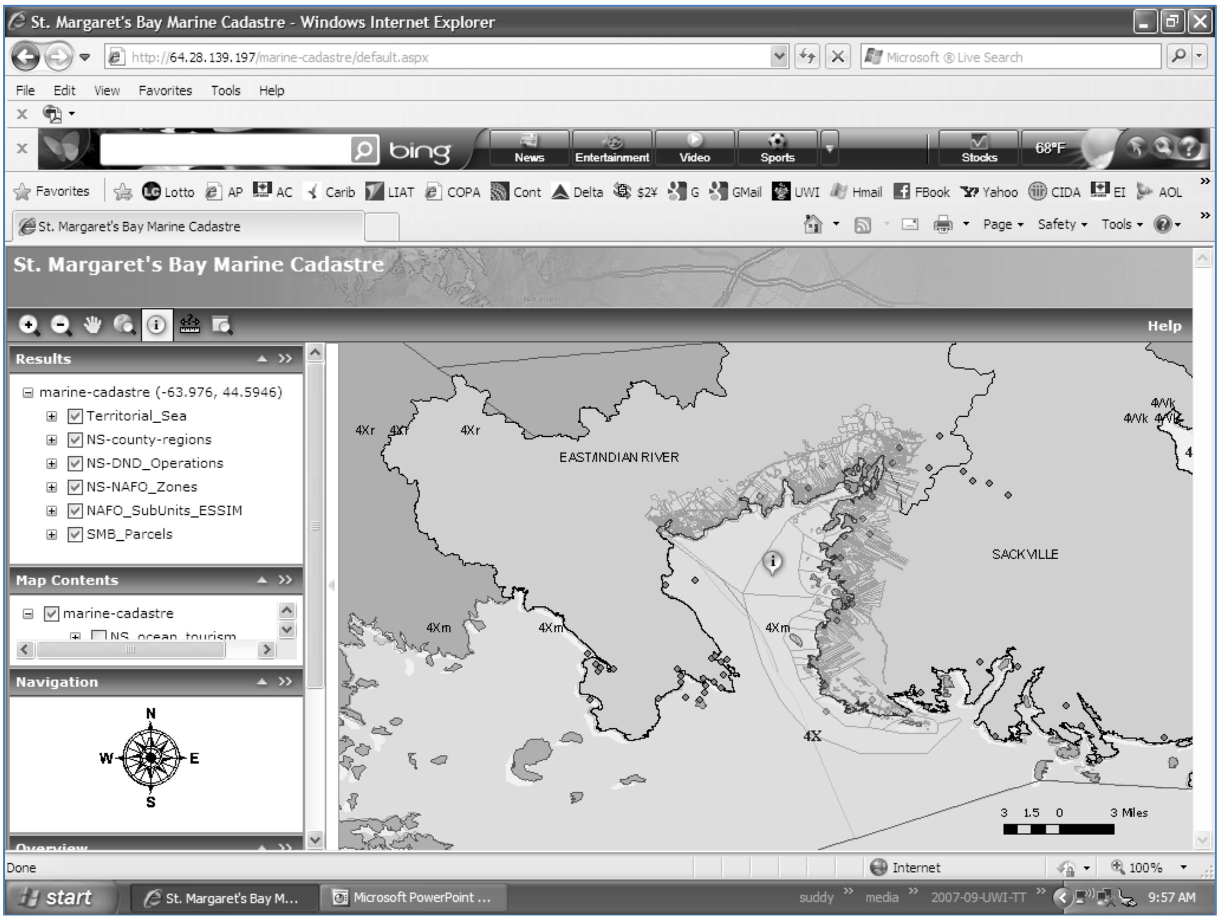

Figure 5: St. Margaret's Bay Marine Cadastre Prototype (Sutherland and Nichols 2010)

3.2 Design of a Marine Cadastre for the Gulf of Paria, Trinidad and Tobago

In 2008 Ms. Carla Taylor, under the supervision of Dr. Michael Sutherland, Department of Geomatics Engineering and Land Management, The University of the West Indies, Trinidad and Tobago, did undergraduate research into the possibility of designing a marine cadastre for Trinidad and Tobago, with focus on the Gulf of Paria (Figure 6) [Taylor 2008]. It was discovered through polygon overlays in a GIS that trawl fishing activities (Figure 7) overlapped with oil and gas activities (possibly pipelines) (Figure 8). While there was no major incident reported, one can imagine what incidents could happen.

Again, the situation described above has MSDI/MGDI implications similar to what was described in Section 3.1. Also AR systems incorporated into the scenario could alert public and private users moving through those spaces that they were traversing sensitive areas.

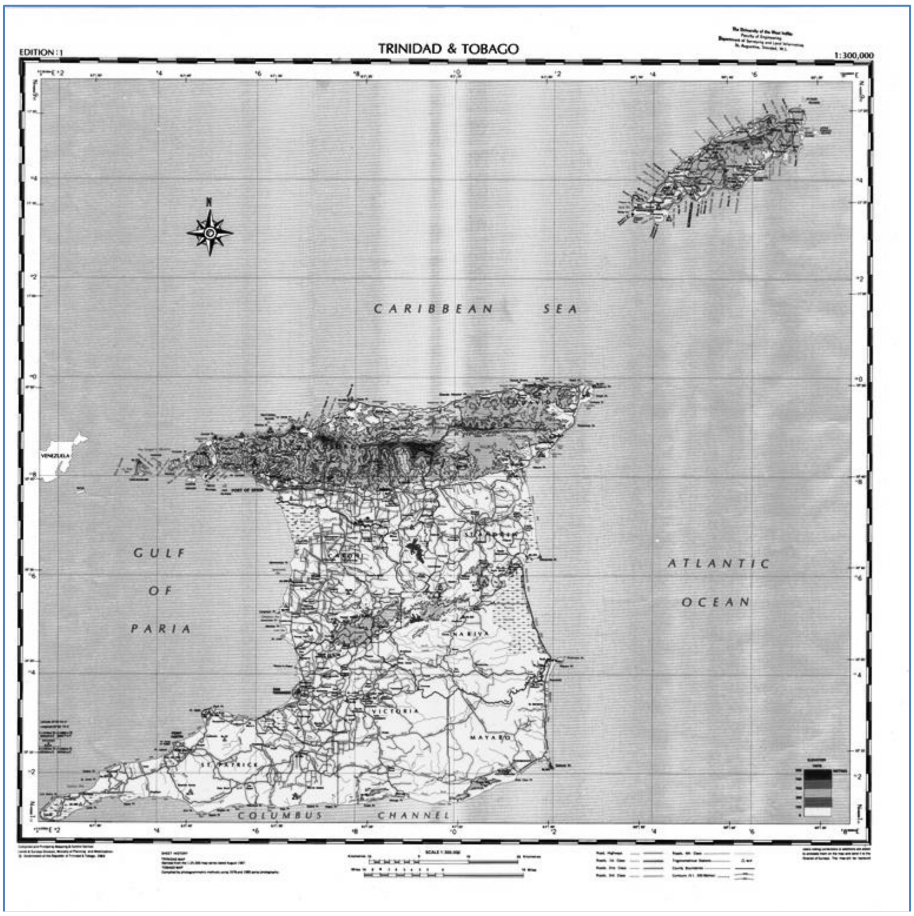

Figure 6: Gulf of Paria, Trinidad and Tobago

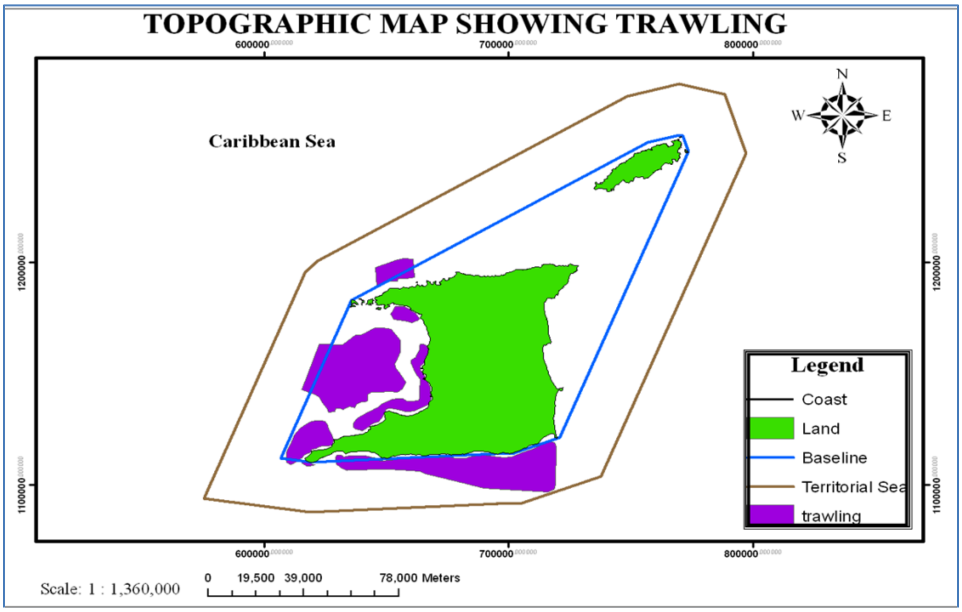

Figure 7: Trawl fishing, Trinidad and Tobago (Taylor 2008)

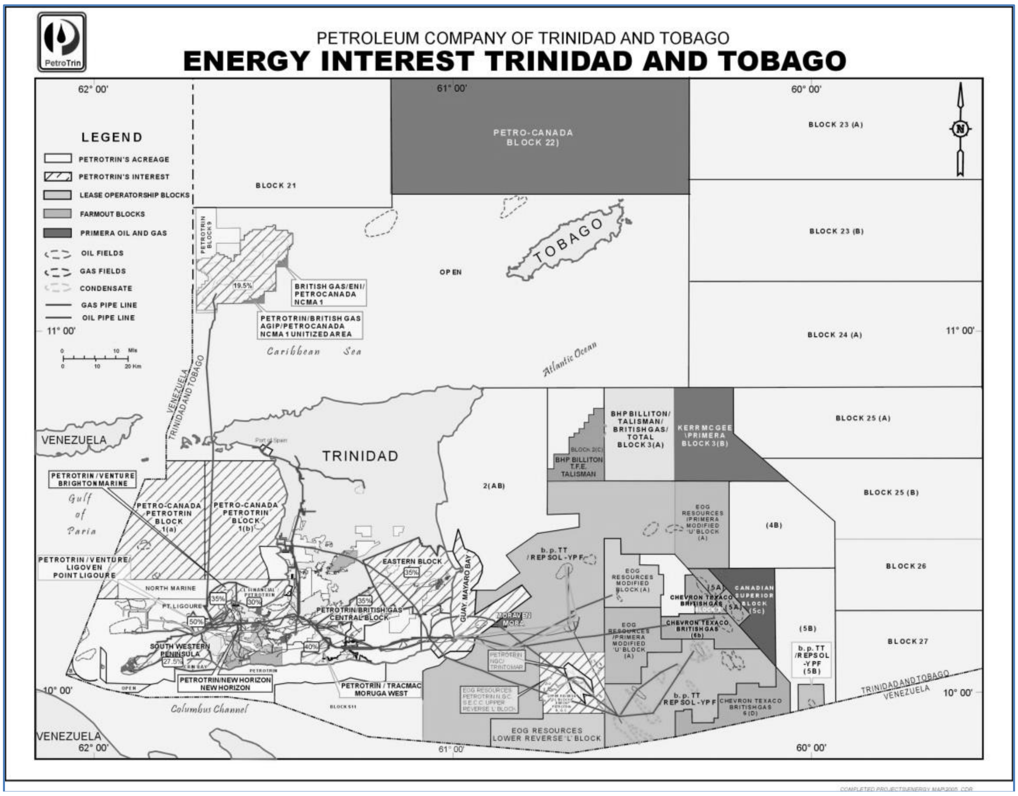

Figure 8: Energy Interests, Trinidad and Tobago (Source: Petrotrin)

4. MSDI/MGDI AND MARINE CADASTRE IN TRINIDAD AND TOBAGO

Griffith-Charles and Sutherland (2014 and 2011) presented information on the non-development of a marine cadastre or MSDI/MGDI in the Republic of Trinidad and Tobago. The authors underscored the need for the development of these systems and frameworks. In the development of a marine cadastre in Trinidad and Tobago, within the framework of an MSDI/MGDI, it would do no harm in considering the inclusion of AR facilities and sub-systems. The country, though not considered a developed economy, is capable of taking advantage of developed technologies. Considering the many and overlapping marine commercial, industrial, private, and public activities that occur in the country’s coastal and marine waters, it is a good idea to provide as much information to stakeholders by as many means as possible, so as to continue to avoid potential disasters and to provide bases for sound decision making.

5. CONCLUSIONS

AR applied to marine spaces could assist MSP through the provision of additional information to persons moving through those spaces. For example, additional information available on site, such as rights, responsibilities, restrictions, subjects of property, or applicable laws (especially in marine environments were boundary delimitation is limited or impossible) could assist in controlling or managing behaviours in ways beneficial to the sustainable exploitation, or management and conservation, of marine resources. The additional information could come from marine cadastres operating in MSDI/MGDI environments. However, the reality of developments (in terms of implementations) in marine cadastres and MSDI remain at the conceptual stages in most jurisdictions, especially in Small Island Developing States (SIDS) such as Trinidad and Tobago, because there is much competition for limited national financial resources and no crisis has yet been directly tied to the lack of these systems.

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BIOGRAPHICAL NOTES

Dr. Michael Sutherland Dip. CS (CAST), M.Sc.E. (UNB), Ph.D. (UNB), MRICS is currently Senior lecturer in Land Management in the Department of Geomatics Engineering and Land Management, University of the West Indies (UWI), St. Augustine, Trinidad and Tobago. He is also Deputy Dean, Faculty of Engineering (UWI). Dr. Sutherland is a member of the Institute of

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Dr Charisse Griffith-Charles Cert. Ed. (UBC), MPhil. (UWI), PhD (UF), FRICS is currently Senior Lecturer in Cadastral Systems, and Land Administration in the Department of Geomatics Engineering and Land Management at the University of the West Indies, St. Augustine, where her research interests are in land registration systems, land administration, and communal tenure especially 'family land'. Dr Griffith-Charles has served as consultant and conducted research on, inter alia, projects to revise land survey legislation in Trinidad and Tobago, assess the impact and sustainability of land titling in St. Lucia, address tenure issues in regularising informal occupants of land, and to assess the socio-economic impact of land adjudication and registration in Trinidad and Tobago, apply the STDM to the eastern Caribbean countries, and document land policy in the Caribbean. Her publications focus on land registration systems, land administration, cadastral systems, and land tenure.

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