

# **Governance in 3D, LADM Compliant Marine Cadastres**

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**Key words:** Marine Cadastre, LADM, 3D Cadastre

## **SUMMARY**

Small Island Developing States (SIDS) generally have much larger marine areas to manage than land areas. This fact provides a challenge for the country's security, governance of use rights, conflict management and resource preservation and sustainable exploitation. The sheer value of these expansive marine areas therefore demands that more attention is paid to using technological and innovative tools to assist in the management exercise. In Trinidad and Tobago specifically, where oil and natural gas reserves within the archipelagic waters and exclusive economic zone (EEZ) are the mainstay of the economy, consideration must be given to the use of technology to support the management of these valuable spaces. The management issue is exacerbated by relatively recent conflict over fishing rights and incomplete resolution of international boundary issues with several surrounding states.

This paper examines the different issues that affect the construction of a 3D LADM compliant marine cadastre in Trinidad and Tobago. These issues are replicated in the other SIDS in the region and internationally. The legislation that defines the rights in the marine environment for the country include the Territorial Sea Act, and the Archipelagic State Act. The technical considerations include the differences among the datums used on land, in the marine areas within the Trinidad and Tobago waters, and in the marine areas of the surrounding states.

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## 1. INTRODUCTION

All of the countries of the Caribbean have marine spaces that are much larger in area than the land space they govern. This is an even larger issue for those countries that are archipelagic states, a status which increases the extent of the space and the resources within their jurisdiction. It can become very difficult for economically challenged Small Island States (SIDS) to perform comprehensive management on these areas while conforming to internationally held best practice in governance models. The states should look to the concepts and technologies being explored currently to investigate whether the tasks can be made simpler and more cost effective while providing equitable use of the land and marine space for all its citizens.

## 2. GOVERNANCE

Good governance on land requires the application of principles that will afford equitable enjoyment for all persons within a jurisdiction while placing equitable responsibilities and restrictions on the use of the land. Land includes the marine environment, the limits of which, for a particular state, are defined by international legislation, treaties, and policy.

A perusal of The World Bank (2002) reveals a definition of governance that equates the concept with the *process* whereby governing entities exercise authority through the enforcement and modification of rules. A variety of other definitions exists, such as those from UNDP (1997), Paquet (1997), Manning et al (1998), Rosell (1999), Kyriakou and Di Pietro (2000) among others. These definitions target organizations, polity, society, and the economy and either explicitly or implicitly refer to concepts of stakeholder authority, coordination, cooperation or integration in decision-making, with objectives ranging from traditions and societal wellbeing to the exercise of power and influence. The heterogeneous nature of governance definitions is understandable when one considers that human societies are themselves heterogeneous in history, culture, socio-political systems, economic systems, resource availability, people-land relationships, and location to say the least.

Location (exposed land or marine) however, and the fact that all human activities have spatio-temporal dimensions, do not receive adequate attention in most definitions of governance. Laws, regulations, policies and traditions are either tied to, or implemented in, defined spaces and this makes boundaries (well defined or fuzzy) of great importance to governance. Laws, regulations, policies and traditions are also rooted in value systems that define rights, responsibilities and restrictions in relation to space and time (defined in varying degrees of precision) and determine how people relate to one another. It is these relationships among people, and their relationships to socioeconomic, political and physical environments that governance must manage so that related defined objectives may be achieved. In trying to

capture these complex relationships, Sutherland (2005) defines governance in terms of the management of stakeholder relationships, as these relationships impact upon societies' current and possible future social, economic, political and physical environments through the frameworks of value systems.

## **2.1 Principles of governance**

In the current global environment of increasing populations, relative limited land availabilities, and threatening natural environmental impacts, stresses on limited resource access and distribution are also increasing. In this situation good governance is essential, in the context of foregoing definitions. Good governance increases the probability that: social, economic, cultural, and political objectives are met; that public services are adequately and efficiently supplied; and that appropriate controls are placed on behaviours that affect the common good within defined spaces (Manning 1998; Sutherland 2005). Good governance on land requires the application of principles that will afford equitable enjoyment for all persons within a jurisdiction while placing equitable responsibilities and restrictions on the use of the land. Land includes the marine environment, the limits of which, for a particular state, are defined by national and international legislation, treaties, and policy.

Generally speaking, principles of governance obviously will vary with value systems. The heterogeneous historical development of cultures and political systems determine this reality. Discourse on these differences is beyond the scope of this paper. The Centre on Governance (1999), the United Nations Development Programme (UNDP) (2011), and Graham, Amos and Plumptre (2003) ascribe to certain principles of good governance to which the authors also ascribe for the purpose of this paper. These principles are based in democratic value systems.

The Centre on Governance (1999) outlines efficiency, accountability, preservation of identity, and the capacity to change as the four principles of good governance. Governance efficiency relates to the provision of low cost, high quality services that support fairly shared socioeconomic obligations and benefits. Accountability requires the identification of governance stakeholders who assume responsibility for prescribed outcomes. These stakeholders include community stakeholders whose identity and culture are to be preserved in the governance process. Very often, changes in physical, political, and socioeconomic environments present challenges to governance. Good governance is expected to facilitate these changes through mechanisms that support flexibility in planning, implementation, and enforcement.

The United Nations Development Programme (UNDP) (2011) describes the following as the core principles of democratic governance: Participation and Inclusion; Accountability and Rule of Law; Non-Discrimination and Equality. Although categorized differently from that in the previous paragraph, these principles are either explicitly or implicitly sanctioned.

Graham, Amos and Plumptre (2003), and the Institute on Governance (2014), describe five principles of good governance (Table 1): Legitimacy and Voice; Direction; Performance; Accountability; and Fairness. Accountability and fairness have already been explicitly mentioned in the previous two paragraphs. Performance as described relate to efficiency and

transparency described in the paragraph relevant to Centre on Governance's (1999) perspective. "Legitimacy and Voice" has been implied in "Participation and Inclusion" mentioned above, and as well in discussions related to preservation of identity.

**Table 1. Good Governance Principles**

(After Graham, Amos and Plumptre (2003) and the Institute on Governance (2014))

<b>Good Governance Principles</b>	<b>Principles</b>
<b>1. Legitimacy and Voice</b>	<p><b>Participation</b> – all men and women should have a voice in decision-making, either directly or through legitimate intermediate institutions that represent their intention. Such broad participation is built on freedom of association and speech, as well as capacities to participate constructively.</p> <p><b>Consensus orientation</b> – good governance mediates differing interests to reach a broad consensus on what is in the best interest of the group and, where possible, on policies and procedures.</p>
<b>2. Direction</b>	<p><b>Strategic vision</b> – leaders and the public have a broad and long-term perspective on good governance and human development, along with a sense of what is needed for such development. There is also an understanding of the historical, cultural and social complexities in which that perspective is grounded.</p>
<b>3. Performance</b>	<p><b>Responsiveness</b> – institutions and processes try to serve all stakeholders.</p> <p><b>Effectiveness and efficiency</b> – processes and institutions produce results that meet needs while making the best use of resources.</p>
<b>4. Accountability</b>	<p><b>Accountability</b> – decision-makers in government, the private sector and civil society organizations are accountable to the public, as well as to institutional stakeholders. This accountability differs depending on the organizations and whether the decision is internal or external.</p> <p><b>Transparency</b> – transparency is built on the free flow of information. Processes, institutions and information are directly accessible to those concerned with them, and enough information is provided to understand and monitor them.</p>
<b>5. Fairness</b>	<p><b>Equity</b> – all men and women have opportunities to improve or maintain their well-being.</p> <p><b>Rule of Law</b> – legal frameworks should be fair and enforced impartially, particularly the laws on human rights.</p>

## 2.2 Governance of tenure

While governance can relate in general to matters of leadership of groups and societies, governance of tenure has been examined as a specific application of governance principles leading to concepts of best practice promoted and adopted for that precise purpose (FAO 2012; Griffith-Charles 2010). Governance of land and land resources requires a specific focus on relationships amongst persons and societies that relate to decision-making on how land is allocated to provide for equity, development and sustainability of civilisation. In this context, spatial information is central to good governance, including cadastral information in the form of spatial extents and boundaries and their relevant attribute information (e.g., rights, responsibilities, restrictions, and the legal persons to whom the interests belong). The centrality of spatial information is the logical basis for the use of land and marine cadastres to support governance processes and decision making (Hoogsteden, Robertson, and Benwell 1999; Nichols, Monahan and Sutherland 2000; Ng'ang'a et al 2004; Sutherland 2005; Nichols et al 2006; Sutherland and Nichols 2006; FAO 2012; Griffith-Charles 2010).

Governance of tenure in its optimal form therefore is constituted of characteristics that support the allocation of land and the administration of land tenure related information. These

characteristics are specifically, as defined by the Food and Agricultural Organization in its prescriptions on ‘Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security’ (FAO 2012):

- Human dignity – that all fundamental human rights should be recognised.
- Non-discrimination – that legislation, policies, nor practice contain discrimination.
- Equity and justice – that there is equality for women, men, youth, and other vulnerable, and marginalised communities.
- Gender equality – that there are equal rights for women in access .
- Holistic and sustainable approach – that a global view is taken of all component activities.
- Consultation and participation – that all stakeholders are included.
- Rule of law – that all laws are publicised and are consistent with accepted international laws.
- Transparency – that all actions and decisions are made public.
- Accountability – that all parties to actions are held responsible.
- Continuous improvement – that appropriate indicators are used to improve services.

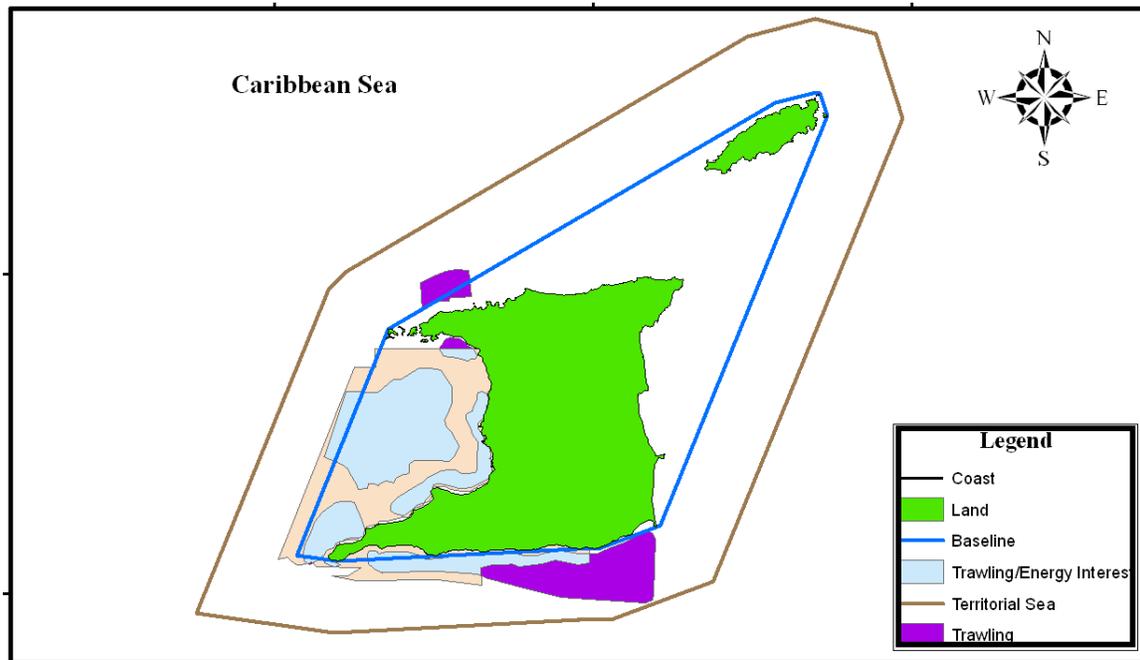
### **2.3 Governance of tenure in 3D**

For the purposes of this paper, “3D” refers to volumes of space referenced or modelled spatially, although time is also an explicit or implicit dimension of all interests in land. The temporal dimension is usually ignored when describing the dimensions of spatial information. Practically, 2D is in fact 3D, and 3D is in fact 4D. This is true even in visualizations of spatial extents because the visualization is a database snapshot of time. Therefore, governance, the management of people’s relationships with one another and defined spaces, is always implicitly or explicitly in 4D (referred to in this paper as 3D). The spaces over which governance mechanisms (i.e., laws, regulations, policies, traditions etc.) are implemented are volumetric spatial extents, whether in relation to marine environments or exposed land. 3D cadastres are therefore appropriate databases to support governance decision making processes (Hoogsteden, Robertson, and Benwell 1999; Nichols, Monahan and Sutherland 2000; Ng'ang'a et al 2004; Stoter 2004; Sutherland 2005; Nichols et al 2006; Sutherland and Nichols 2006; Griffith-Charles and Sutherland 2013).

### **2.4 Governance of tenure in Trinidad and Tobago**

Governance of tenure in the Caribbean and in Trinidad and Tobago, where the focus of this examination lies, is impacted by the physical factors of geography, geomorphology, demographics and location with respect to natural hazards (Griffith-Charles 2010). The application of governance in the region must also function within the particular characteristics of the politics, culture, history, and precarious economies. Trinidad and Tobago’s land tenure is generally beset by issues of large scale insecure and informal tenure, illegal occupation and use of land, use and degradation of environmentally sensitive and other marginal and unsuitable land, bureaucratic and lengthy land administration procedures and inadequate land information systems, historical inequity in access and distribution of land, and land conflicts exacerbated by overburdened legal systems (Griffith-Charles 2010, 2011). Not all of these issues would have a concomitant impact in the marine areas but some are more significant. Issues in the coastal area extend both landward and seaward with no clear demarcation between the two spaces. In this area conflicting uses occur between tourism, fishing, oil and

natural gas exploration, and yachting (See Figure 1). These activities overlap both horizontally and vertically leading to a need for 3D cadastres to manage the information that would support responsible governance of tenure. The total area within the archipelagic baselines required to be managed by Trinidad and Tobago sums to 12,262 square kilometres which comprises of water area of 7,134 square kilometres and land area of 5,128 square kilometres.



**Figure 1. 2D visualisation of marine spaces in Trinidad and Tobago (Taylor 2008)**

To be able to meet the requirement of responsible governance of tenure in the marine spaces the state would need to establish a 3D cadastre that would allow the visualisation of the conflicting, overlapping and interspersed uses that currently occur while paying heed to the principles espoused by the FAO in its guidelines or by the World Bank in its Land Governance Assessment Framework (LGAF) (Deininger, Selod and Burns 2012). This would mean that fundamental human rights of fisher folk will be recognised and their traditional fishing areas demarcated on the cadastre along with the rights of larger foreign fishing companies and multi-national oil and gas companies with equity, transparency and accountability in mind. Conflicts have occurred between these entities on several different occasions in the recent past resulting in protests and legal action. The rights of the more vulnerable parties have had to be championed by supportive individuals and NGOs (See for example [http://www.ema.co.tt/new/images/pdf/fishermen\\_and\\_friends\\_pc.pdf](http://www.ema.co.tt/new/images/pdf/fishermen_and_friends_pc.pdf)). Barbados and Trinidad and Tobago had a dispute over the rights to the Flying Fish in the waters between the countries that was ongoing for 14 years. The case was settled in Permanent Court of Arbitration in 2006.

### 3. MARINE CADASTRE DATA MODELS

Since 1999 (Hoogsteden, Robertson, and Benwell 1999) the concept of marine cadastre has been present in Geomatics-related research and professional literature. A number of jurisdictions in North America, Australia, the Middle East, and South East Asia (among others) have shown interest in the concept. This is because marine environments are subject to a myriad of overlapping legal interests due to international and national institutional frameworks. Some of these rights include United Nations Convention on Law of the Sea (UNCLOS) and national maritime zones, environmental protection and management rights, sovereign and administrative rights, private commercial rights, navigation rights, customary rights, public access rights, benthic and pelagic fishing rights, riparian rights, development rights, mineral resources rights, benthic and seabed subsurface resource rights, and even residential rights, to name a few (Binns and Williamson 2003; Fraser, Todd and Collier 2003; Ng'ang'a et al 2004; Fulmer 2007; Sutherland and Nichols 2009; Srebro, Fabrikant and Marom 2010; Rahibulsadri, et al 2014).

There is a plethora of articles and papers on the subject of marine cadastre that deal with varying technical, institutional, legal and stakeholder issues. However, there is a dearth of literature and research that deals with marine cadastre data models in terms of data objects and the relationships among them, in a manner that captures the obvious 3D nature of the marine environment and the associated range of possible legal interests. Among the exceptions is Ng'ang'a et al (2004) which describes a marine parcel data model (Figure 2). The model attempts to facilitate cognizance of the various physical layers of marine spaces, the natural resources existing in these spaces, the interests that could occur, and the legal persons to whom the interests could be ascribed. Taking this approach to data modelling, and within the context of this paper's objective, the question arises as to whether the LADM is adequate to model required data and their relationships, relevant to marine spaces.

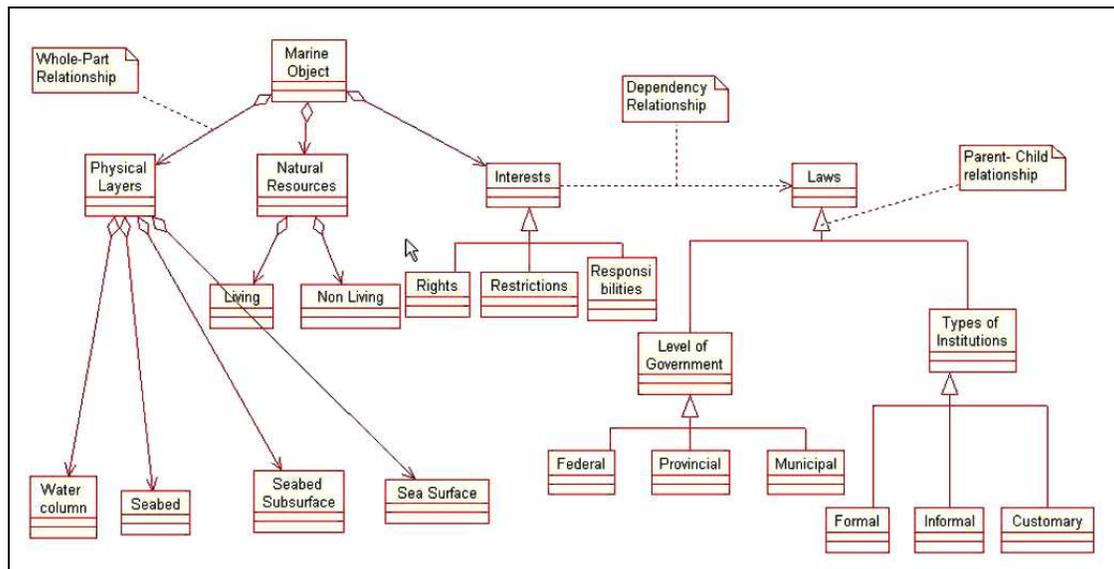


Figure 2. Marine Parcel Data Model (From Ng'ang'a et al (2004))

## 4. APPLYING THE LADM TO THE MARINE ENVIRONMENT

The Land Administration Domain Model (LADM) conceptualises the existence of three basic entities to define and support the rights, restrictions and responsibilities on land for the rights holder. The rights holder, the parcel and the evidence of rights are represented in the model by four packages related to the party, the basic administrative unit and the rights restrictions and responsibilities, the spatial units or parcels, and the administrative source (See Figure 3). The application of the LADM to the marine environment highlights the differences that can arise in the application of the concept to various different jurisdictions. The main issues are in the decisions to be made regarding the visualisation of the basic administrative units and any derivative spatial units, and in the linking or interfacing of the land based cadastre with its own existing standards with newly defined standards in the marine space.

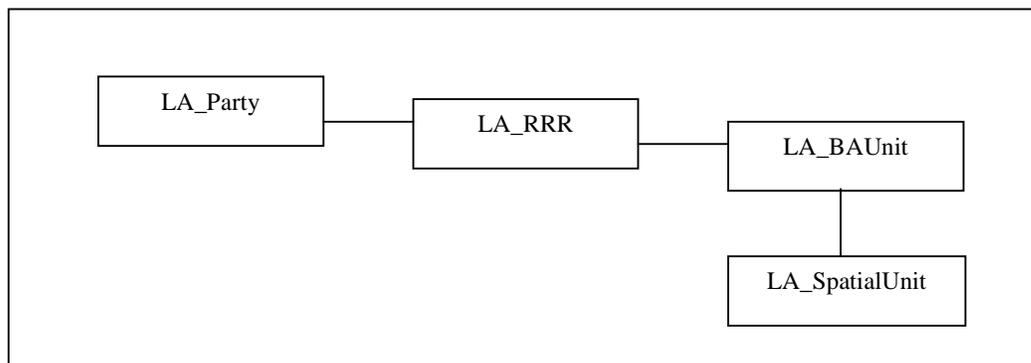


Figure 3. Basic classes of the LADM (ISO 19152 2012)

### 4.1 Party

The Party for a land based cadastre may be the individual with an interest in land or a company or group. A party can also be a dominant tenement in an easement. In the marine environment, the Party is less likely to be an individual and would most likely be a group, such as a fishing cooperative, oil mining company, or shipping company as examples. Trinidad and Tobago has very little history of granting individual fishing licences although some trawling licences have been granted to foreign companies who perform trawling along the sea floor. The attributes required for the LA\_GroupParty include the groupID which would be a registration number given to the group as their rights are being recorded.

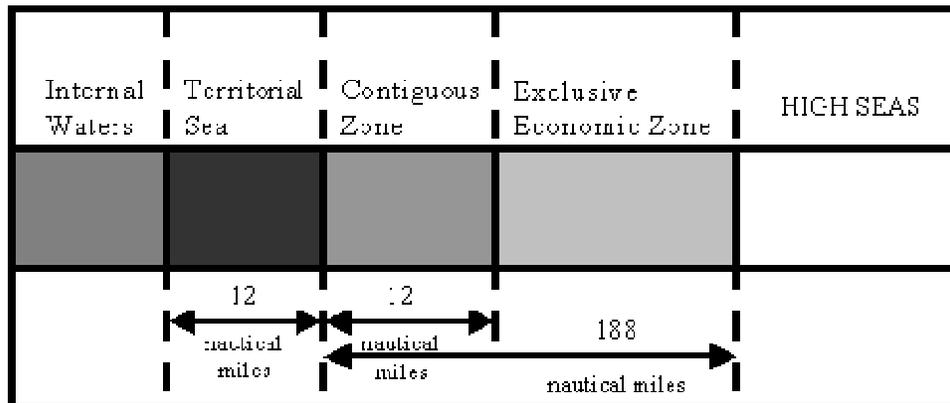
### 4.2 Administrative Source

The administrative source (LA\_AdministrativeSource) in the marine environment defines the authority by which the space is being used. The attributes include text that indicate the contents of the document that authorises use such as a licence to fish or a lease to explore for oil and gas.

### 4.3 Basic Administrative Unit

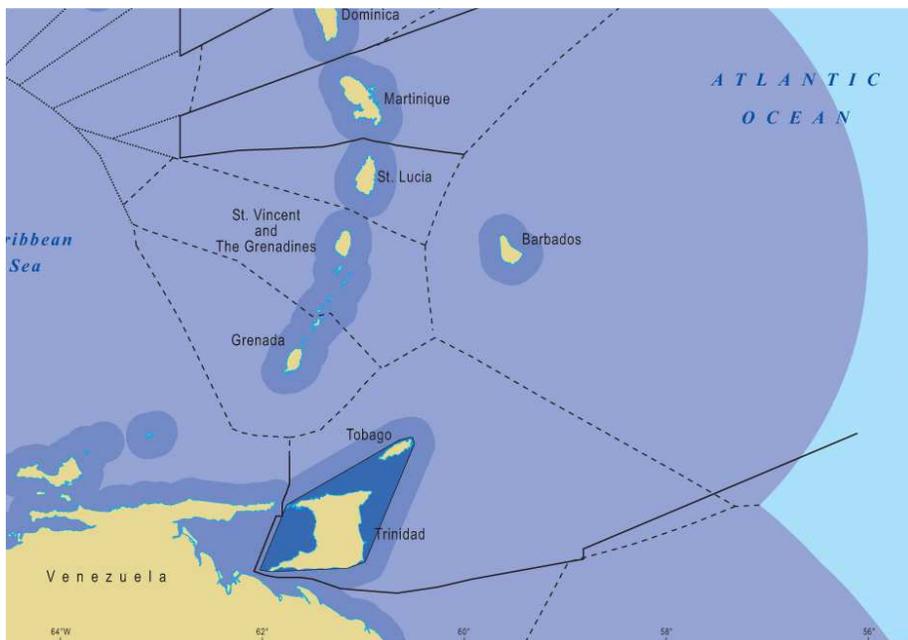
The basic administrative unit defines, in the marine space, the extent of the volume of space held under one unique and homogenous right. The Internal Waters, Territorial Sea, Contiguous Zone, and Exclusive Economic Zone (EEZ) are all legally defined and would

each comprise a basic administrative unit since they each would have a unique, homogenous right with defined rights, restrictions and responsibilities (See schematic diagram in Figure 4).



**Figure 4. Schematic structure of the legally defined marine space required to be managed in Trinidad and Tobago**

The EEZ is much narrower than the 200 nautical miles from the outermost boundary of the territorial sea as shown as a result of the country’s proximity to neighbouring countries. The actual boundaries are required to be negotiated with all the countries that share overlapping spaces in the EEZ. Trinidad and Tobago has completed this negotiation with Venezuela but must continue these negotiations with the other neighbours including Barbados, Grenada, and St. Vincent and the Grenadines.



**Figure 5. Overlapping EEZs and approximate median lines for countries neighbouring Trinidad and Tobago**

#### 4.4 Spatial Unit

While spatial units in the land cadastre can have specialisations where buildings can coincide with the legal space, this is very rarely if ever existent in the marine cadastre. The specialisation of utility networks can and do occur in the marine space where gas, oil and electricity pipelines run along the surface of the sea floor. The surveying and representation subpackage captures the spatial extent of the rights, restrictions and responsibilities. The physical presence of the pipelines exclude any other rights from being present in that space so the visualisation of the pipeline indicates the restriction boundaries for any other party. This situation can be captured in the LA\_RequiredRelationshipSpatialUnit class since measurements would not be accurate enough to indicate the limitations of either entity and a seeming overlap in the visualisation must be avoided. This is different for rights that coexist such as rights to fish for one party and rights to moor yachts for another party where these occur. The visualised extents of both of these spatial units can overlap and coexist. The coordinate system can be specified to be WGS84 UTM to allow smooth transitioning between the land cadastre and the marine cadastre. Marine spaces conventionally use geographic coordinates and these can be attached as an attribute. Table 1 shows the coordinates of the archipelagic boundaries of Trinidad and Tobago (United States Department of State 2014). Figure 6 shows the locations of these points on a map of Trinidad and Tobago.

**Table 2. Coordinates of archipelagic boundaries of Trinidad and Tobago**

Point Number	Feature Name	Coordinates (WGS 84)
1	East Rock	10°08'18.4"N 60°58'56.1"W
2	Casa Cruz Rock	10°04'28.4"N 61°09'39.1"W
3	Alcatras Rock	10°04'25.4"N 61°13'22.1"W
4	Icacos	10°02'34.4"N 61°54'24.3"W
5	Black Rock	10°03'33.4"N 62°01'27.3"W
6	Cabresse Point	10°41'53.4"N 61°45'30.2"W
7	Cabresse Island	10°42'04.4"N 61°45'19.2"W
8	Sisters Island	11°20'03.5"N 60°38'36"W
9	Marble Island	11°21'45.5"N 60°31'31"W
10	St. Giles Island	11°21'34.5"N 60°30'46"W
11	Little Tobago	11°17'45.5"N 60°29'34"W



Figure 6. Baseline points of the archipelagic boundaries of Trinidad and Tobago (United States Department of State 2014)

## 5. 4D MARINE CADASTRE

The LADM standard can allow the recreation of a dataset at a previous point in time leading to a 4D visualisation of the cadastre. This is possible with the inclusion of the class ‘VersionedObject’ which would contain any entity that has a beginning and an end of existence. The attributes are therefore beginLifespanVersion which is the start time of an instance in the class. This can be used for all licences and leases occurring in the space. The constraint is that all instances must have a startLifespanVersion value of  $n$  while the endLifespanVersion value is  $n-1$  where  $n$  is the number of times it appears.

## 6. ANTICIPATED CHALLENGES TO THE APPLICATION

The application of the LADM in a 3D marine cadastre in Trinidad and Tobago will have varied challenges that may be economic, social, as well as technical in nature.

### 6.1 Economic Challenges

Economic challenges to constructing and maintaining the marine cadastre can be minimised by the use of free and open source software to manage the data. The largest costs will be for

the capacity building of current and new dedicated staff to establish, operate, and maintain the system. If responsibilities are shared amongst the institutions currently responsible for maintaining 2D information in the marine environment the costs and disruption can be minimised but coordination of the whole will become complex. Currently, the Ministry of Energy and Energy Affairs maintains plans of the areas leased to concessionaires for exploration for oil and gas. Data external to the LADM can continue to be maintained by this agency but must be provided in the documented formats.

### **6.2 Social Challenges**

Access to the database should be provided to groups who have their rights represented in the system. A point of access should be made accessible to fisher folk but others can access the data online if this is developed. Traditional rights of access that are not formally supported by documentation should be recorded using Social Tenure Domain Model (STDM) specifications and should form part of the database and visualised accordingly so that users can differentiate between the information types.

### **6.3 Technical Challenges**

The marine cadastre can be constructed, as the LADM allows, so that different agencies can be responsible for establishing, maintaining and disseminating different datasets for the different packages but that all the datasets will be able to speak to each other once the documented standards for the different elements are maintained. This is a benefit of the LADM where standards are provided and can be conformed to by all institutions.

## **7. CONCLUSION**

The system proposal described here will allow the country to go forward substantially to meet the requirements of responsible governance of tenure in the marine environment. The actual use of the system for governance may provide the greatest challenge in implementing the system as it would require adoption by the groups whose rights are being captured in the system and also adoption by the land management institutions as part of their land management activities. It is to be hoped that the visualisation of the space in 3D would provide for ease of understanding of what is to be managed and a reduction of effort in decision-making. It can also support the informal, customary rights of use of vulnerable groups if the extents of these rights are approximately recorded.

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