Guest Editorial: Rivers, Beaches and Leatherback Turtles: the Case of Grande Rivière

Grande Rivière Bay, in north-east Trinidad (Fig. 1), is one of the world's most important sites for the conservation of the Leatherback Turtle (*Dermochelys coriacea*), a species declared critically endangered by the International Union for the Conservation of Nature (IUCN 2012) in 2000. Grand Rivière Beach supports the highest nesting density in the world (Wider Caribbean Sea Turtle Conservation Network 2008) and at the height of the nesting season hundreds (with estimates of up to 300-500) of female turtles climb onto the beach in the hours of darkness, lay their eggs and return to the sea. As global nesting populations may have fallen as low as 26,000 to 43,000 females (US Fish and Wildlife Service 2007), it is a key nesting site, and the nesting event is the focus of a thriving eco-tourist industry, bringing much needed economic benefit to this remote community.

In July 2012 Grande Rivière hit the world's news headlines (BBC 2012a). A flood in the Grande Rivière River, unable to reach the sea directly through the beach, diverted westwards into the 200 metre stretch which is the focus of tourist activity, cutting a channel through the back beach (Fig. 2) and destroying hotel infrastructure (Fig. 3). The Ferdinand River, 200 metres to the west, followed a similar pattern. In response, the Ministry of Works sent in a heavy excavator to create a sand berm and cut off the new channel. In doing so they excavated and crushed some 20,000 turtle eggs and hatchlings, estimated at 10% of the total annual lay (BBC 2012b). This figure was disputed by the Environmental Management Authority (Boodram 2012), amidst claims that 'over a million turtles had been saved by the intervention' (vtbirch101 2012). As images of dead hatchlings circulated the globe, and the procedure was condemned by the Minister of Planning and Sustainable Development (La Vende 2012), local and global conservation communities responded with consternation. Six months later, with no firm data available on egg and hatchling loss, the local community and the Trinidad and Tobago Government are debating not only the circumstances of the event, but the long-term issues of how to prevent its recurrence, and indeed, the complex issues surrounding the management of such small, but vital, part of the natural estate. As independent scientists involved in the monitoring of the beach and its turtle community, we would like to offer comment on some of the issues at stake.

First, consider the beach itself. Beaches are highly dynamic landforms responding constantly to energy flux. Few of Trinidad's beaches are of any great age, because they are ultimately controlled by the altitudinal relationship between land and sea. Maracas Beach, for example, has been dated to around 3,000 years old (Ramcharran 2004). They are subject to wave regimes and currents, which are distributed up and down the beach by the tidal cycle, operating on daily, lunar and annual time scales. Erosion and removal of beach sand tends to take place during short-term (hours/days) high energy events, whilst accretion is favoured by a longer (weeks/months) low energy regime. Although the beach can be eroded at any time, most erosion takes place during the northern winter (October to March), when Atlantic storms set up destructive swells, characterized by large breakers.

Rivers bring water and sediment from the Northern Range to the beach. There may be a gap in the beach through which the river can flow on a day-to-day basis, but in the case of most high energy flow events, the river ponds behind the beach, spreading onto the surrounding flood plain, and then spreading laterally to find the line of least resistance to the sea. Most floods occur during the wet season (June to December), with flow diminishing to almost zero during the dry months.

If we ask what the optimum conditions for turtle nesting are, two factors are obvious. First, during the nesting season (February to August) the leatherback requires a broad beach, stable in terms of both morphology and sand volume. The average depth at which the turtle lays eggs is around 70 cm, therefore removal of a metre depth of beach sand will also terminate the nests within it. Conversely, if a metre of sand is added, it will disadvantage hatchlings, which will have further to climb through the sand. In terms of erosion across the beach profile, the loss of a few metres on the seaward face is far less important than the back beach, where most turtles nest.

Second, outside of the nesting season (September to January) the interests of the turtle are best served by the removal of the beach and its replacement with fresh sand. An accumulation of 'stale' sand and old nesting debris leads to an increase in potentially harmful parasites and pathogens (Conrad *et al.* 2011) which jeopardize nesting success.

In these terms it would appear that the leatherback has adjusted well to beach dynamics. Beach replenishment takes place outside of the nesting season, whilst the maximum nesting activity takes place between April and June, when the chances of beach stability are greatest. However, high seas, combined with spring tides, can occur at any time of the year. The beachfront hotels lost business in April 2009 due to inundation by unusually large waves and the Grande Rivière River is known to have flowed westwards in earlier years, notably 2003. Many local

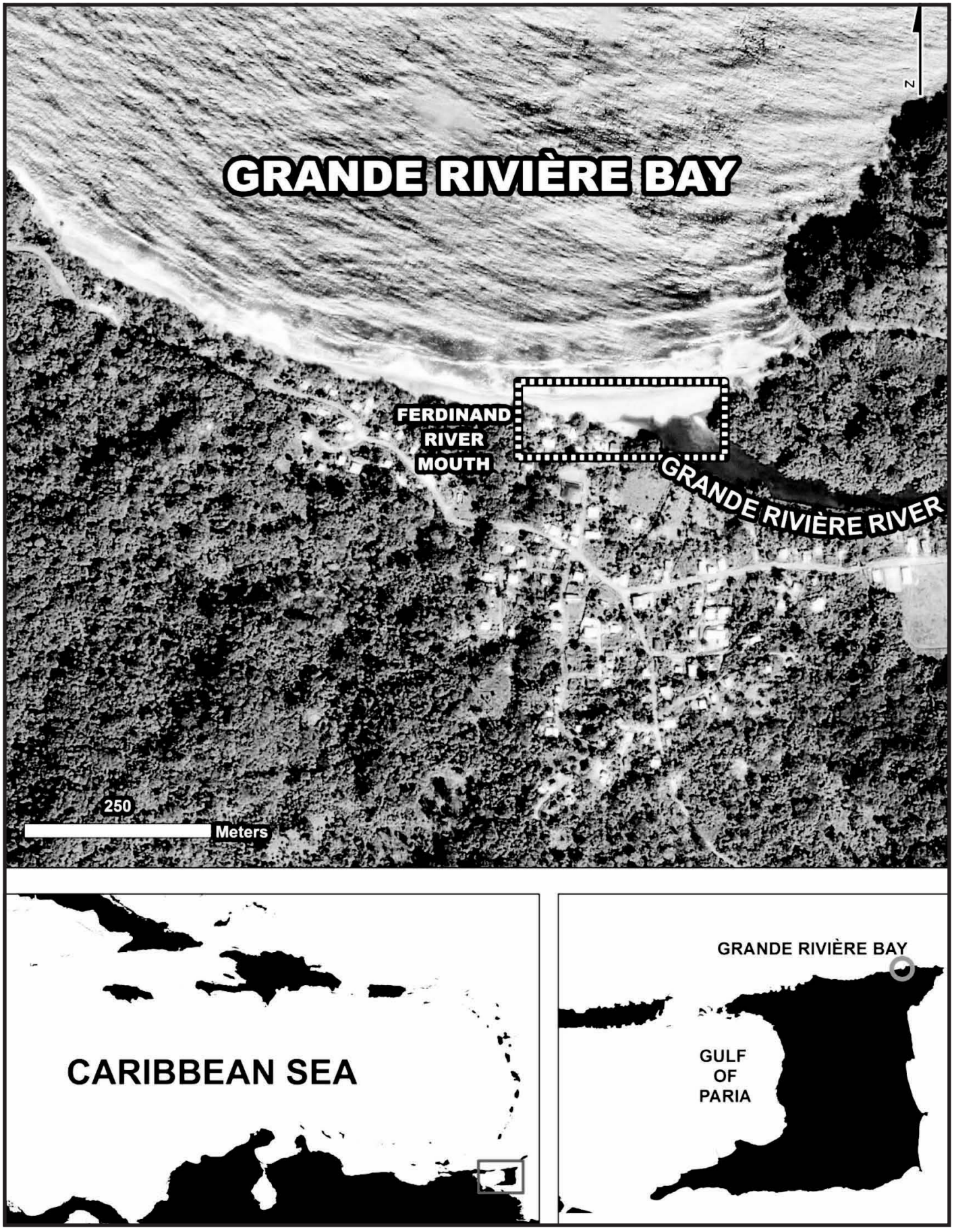

Fig. 1. Grande Rivière Bay, location and Google Earth image.

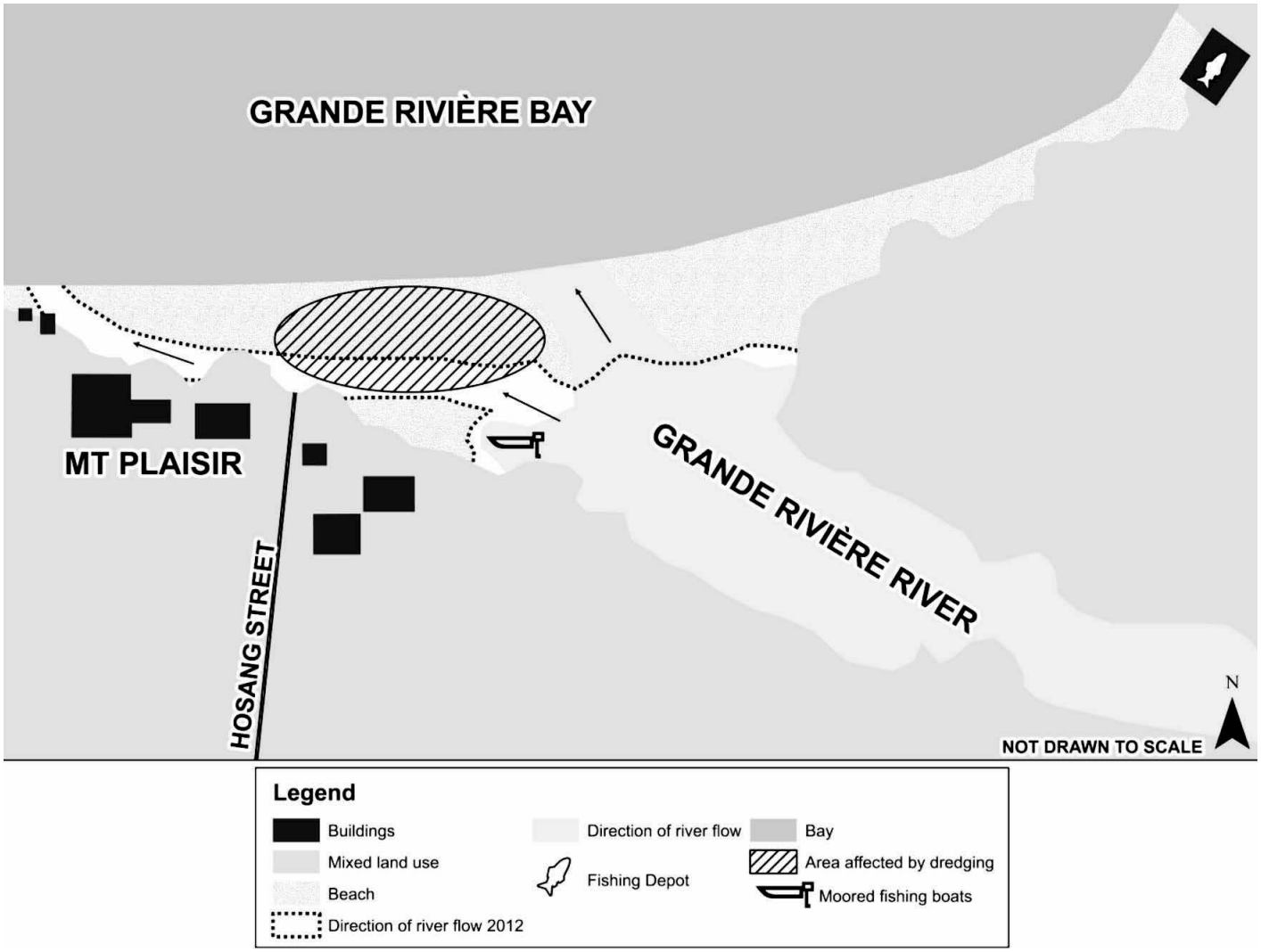

Fig. 2. Sketch map showing location of features mentioned in the text.

residents are of the opinion that the switch in river flow is part of a cycle that occurs every 10 to 20 years.

Was there any culpability of the local community in the July 2012 event? Natural hazard modelling posits the existence of unseen but potentially important factors in all disaster events. In this case it was not the tardiness of the Ministry of Works in responding to protests by local hoteliers when the rain began (Moe 2012), but less obvious issues. The July flood was essentially the first of the wet season – meanwhile the mouth of the Grande Rivière River had been allowed to close up, as fishing boats had not used it for access for some weeks. This, in turn, built up water behind the beach. In such circumstances the river normally flows eastwards, either by channelling through the back beach, or flowing across the natural flood plain. This area is undeveloped and forms a natural sacrifice zone. Indeed this has long been recognized by the community and a sluice gate had been constructed at the Fisheries Depot at the eastern end of the beach to release flood water. In this case the system was in a poor state of repair, and the gate is rumoured to have remained closed in July. (At the time of writing – January 2013 –remedial works on the sluice are taking place). Further, a flood defence embankment of unknown legality has been constructed along the eastern river frontage, which can only exacerbate the problem. Clearly there are issues of preparedness which the local community needs to discuss.

Long-term plans for rehabilitation also need to be reviewed critically. Artificial replenishment of the beach has been mooted; bringing in truck loads of sand from adjacent coastal areas. This is a waste of time and money. The Grand Rivière Bay is a closed sediment cell in which loss of sediment takes place to the offshore zone during high energy events, with return during calmer conditions. The database of beach profiles collected by the Institute of Marine Affairs and Department of Geography, UWI, over the past decade confirms this. Likewise a permanently engineered river mouth, as proposed by the former Minister of Works in December 2011 (vtbirch101 2012) is undesirable; at the very least it would disrupt longshore

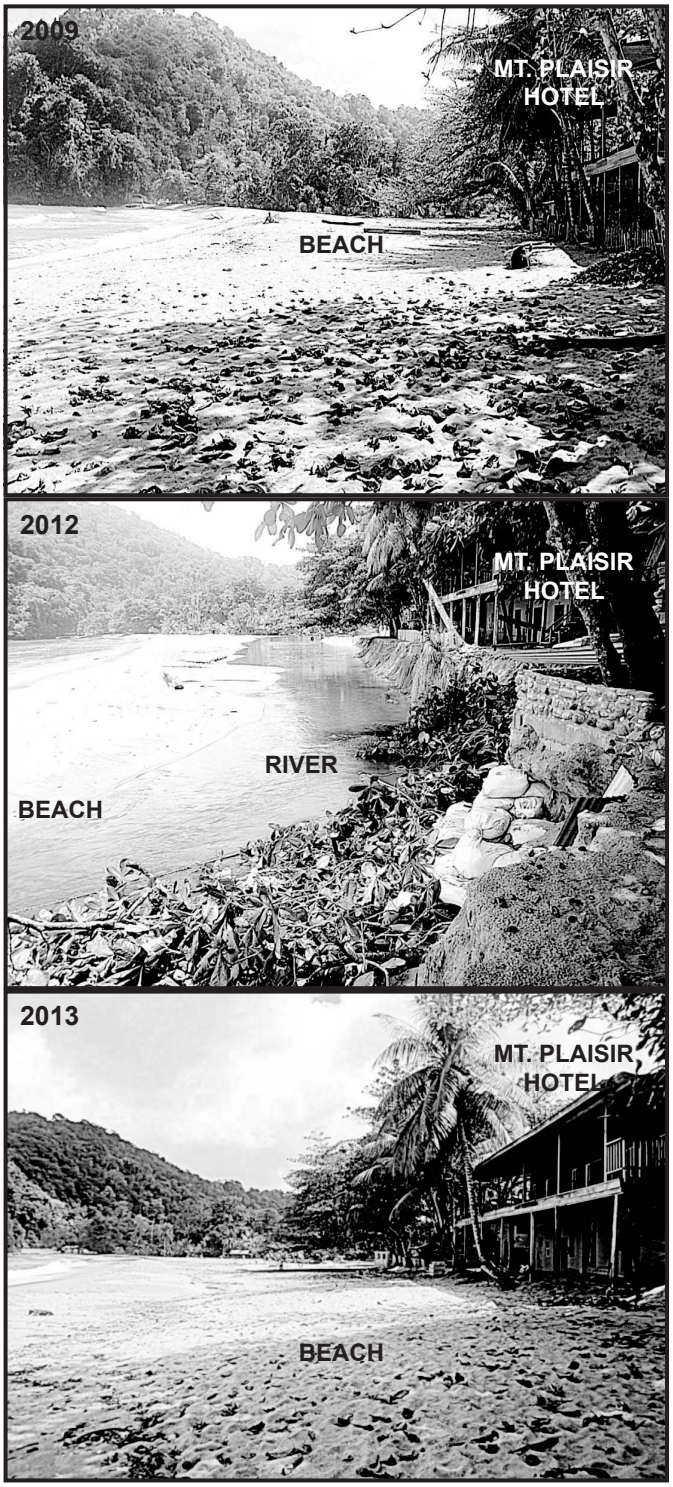

Fig. 3. Photos of the beach looking east at the Mon Plaisir Hotel in 2009, July 2012 and January 2013 (see text for details).

sediment transport and create pockets of unrecycled sand. Probably it would be impossible to maintain.

What is apparent is that constant change is part of the system dynamics. Leatherback turtles have negotiated shifting beaches and river mouths for over 100 million years, on coastlines long disappeared on continents that have shifted way beyond recognition. Events such as July 2012 are merely minor positives and negatives on the long-term balance sheet, and bulldozing the beach was ultimately not about saving turtles, but about saving private property. It would be more useful, if we are focusing on contributing to the increasingly unlikely survival of the species, to consider the factors that have led to its dramatic 80% population crash in the Pacific within a generation (Spotila *et al*. 2000), including excessive coastal development, light pollution (the unscreened street lights on the Matelot Road come to mind), illegal fishing practices and the mass dumping of plastic waste into the hydrological and oceanic systems (Crowder 2000).

It may be that the Grande Rivière community, who are just as aware of cyclical beach changes as the most dedicated scientist, regard the preservation of the small 'golden triangle' of sand between the Grande Rivière River and adjacent Ferdinand River as an essential part of the eco-tourist effort. Certainly it is part of an iconic Trinidadian landscape, familiar to us all. The Mon Plaisir Hotel, originally a plantation house, would merit conservation status in most countries. In this case the procedures are clear – mechanical intervention may become necessary as a last resort, but it should be timely and minimal. It should also be based on monitoring (our records of beach morphology and turtle nesting sites are much improved in the last decade, but the river still remains ungauged), modeling and planning at both government and local community level. Only then do we have a clear conscience to enjoy the turtles while they last.

Postscript: In January 2013 (Fig. 3), high seas pushed the front beach landwards, thus restoring the shoreline to its 'normal' condition. Optimum conditions for the 2013 nesting season have been restored.

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