FIRST REPORT BY CARMABI REGARDING THE JAN KOK OIL SPILL AUGUST 26TH 2012

His report is solely intended to describe the effects and future ecological consequences of the oil spill that occurred in August 2012.

WHAT HAPPENED?

Since August 16th 2012, local authorities (Coastguard, Havendienst, Oil response coordinator etc) were warned that a large had occurred at the oil facility at Bullenbaai. The concerns were repeated but hardly any action was taken. Later in the week, while tropical storm Isaac, caused unusually strong south winds, much of the oil got trapped in the northwestern corner of Rif Marie where it entered the saliña of Jan Kok through a man canal. Serious responseS to the ongoing disaster were started on Saturday, August 25th, almost a week after the spill had occurred.

HISTORIC USE OF THE AREA

Small-scale salt harvesting used to take place in the Rif-Sint Marie saliña, by means of the construction of small crystallizers. In the mid-1960s, salt harvesting was no longer profitable, and the crystallizers were left abandoned (Debrot & de Freitas 1999). In the past, a canal was dug through the coral barrier thus connecting the saliña directly to the sea. Because of this man-made channel, salinity levels inside the saliña dropped below 130 ppt, allowing predatory fish to survive causing the (near)absence of Brine shrimp (*Artemia saliña*) and the Brine fly (*Ephydra cinerea*), which are preferred food species for flamingos. Therefore, this channel had a direct negative influence on the quality of this foraging habitat for the Caribbean flamingo (Debrot 1999; Cuppens & Vogel 2004). The outflow of turbid freshwater through the same canal during heavy rainfall imposes potential stress to coral reefs of the area. However, occasional inflow of sea water to the saliña is necessary to prevent complete evaporation of the lagoon. A system of sluices could be a good compromise to manage the salinity of the saliña (Debrot 1999). Presently, a major threat to the area is uncontrolled recreational access by hikers who bring dogs and disturb the flamingos. A few fishermen occasionally use nets to catch bait fish in the area. Development of touristic habitations in the western side of the area represents the largest threat to the ecological integrity of the Ramsar site. Removal of vegetation during construction could lead in an increase of mud runoff into the saliña. Leaching from septic tanks of these habitations has also been proposed as a possible future threat to the area. Oil contamination from the oil terminal at Bullenbaai represents the main threat to coral reefs in the area (Debrot 1999).

ECOLOGICAL VALUES

The saliña of Rif-Sint Marie is an important foraging area for the Caribbean flamingo (*Phoenicopterus ruber*, Chochogo) which is listed as Conserved Through Agreements under appendix II of the Convention for Migratory Species (CMS) (Cuppens & Vogels 2004; Smelter 2005). The saliña of Rif-Sint Marie is crucial to maintain viable populations of the Caribbean flamingo during the dry season when the larger wetlands of Venezuela (where part of the population forages) run dry (Debrot & de Freitas 1999). Furthermore, the increased abundance of flamingos on Curaçao since the early 90's suggests that the (growing) breeding population on the nearby island of Bonaire (up to 1,300 pairs nesting in Pekelmeer Saltworks IBA/Breeding Reserve/Ramsar site (Wells & Debrot 2008)) is spreading out and has started colonizing suitable habitats on neighboring islands, such as Curaçao (Debrot & de Freitas 1999). The saliña of Rif-Sint Marie provides important food sources for these flamingos and is part of a network of feeding sites for this species, not only on Curacao itself, but also within the Southern Caribbean Ecoregion.

The saliña lays inland from a coral reef-fringed bay and is a former inland bay that had no direct connection to the open ocean (Boekschoten 1982). The total surface area of the saliña is approximately 130 ha and it has an average depth of only a few meters. A man made canal now cuts through the barrier of coral debris and connects the saliña with the open sea. The saliña's salinity level is only slightly higher than sea water as a result of the man-made connection to the sea. Mean salinity lies around 40 ppt but varies spatially within the saliña depending on the distance to the opening to the sea (Cuppens & Vogels 2004). Dissolved oxygen concentrations and mean temperature of the water inside the saliña average around 8.6 mg/L is and 31 °C respectively. Water clarity varies through time depending on precipitation and ranges between 9 and 150 cm.

The soil of the saliña consists mostly of clay but also includes silt, sand, gravel and small calcite crystals (Cuppens & Vogel 2004). The fringing coral reefs in the area are characterized by a narrow submarine terrace (<150 m wide) which gradually slopes from the shore to a drop-off at approximately 7 to 12 m depth. At the drop-off, the reef slopes off steeply, sometimes interrupted by a small second terrace at 50 to 60 m, and ends in a sandy plain at 80 to 90 m (Bak 1975).

Environmental parameters inside the lagoon such as temperature, salinity, pH and turbidity fluctuate heavily throughout the year and foremost dependent on the level of rainfall. The communities inside the lagoon change with changing water conditions that range from brackish conditions after heavy rainfall to hyper-saline conditions after prolonged drought. Curaçao's daily tidal range is small (30 cm), only during strong winds the tidal range can be bigger with a maximum of about 70 cm (de Haan & Zaneveld 1959).

The marine life inside the Saliña Rif-Sint Marie includes the seagrass *Ruppia maritima,* marine invertebrates, along with a wide variety of fish species (mainly Cypronodontids, Mullidae, Gerridae, Centropomidae, Albulidae and Elopidae), tunicates and jellyfish. In the sediments, oligochaetes and amphipodes are most commonly found while copepods are most abundant in the water column. Food sources for the flamingos that forage inside the Saliña primarily consist of small cyprinodontid, oligocheates, snails and amphipodes. The mean biomass of all these potential food sources combined is on average 2.90 mg/dm^3 (dry weight) (Cuppens & Vogel 2004). Since the water saliña is only slightly elevated in salinity relative to seawater, the Brine shrimp (*Artemia saliña*) is nearly absent while the Brine fly (*Ephydra cinerea*) is completely absent. Annual fluctuations in salinity levels of the saliña related to varying precipitation levels causes corresponding changes in the composition of the marine communities inside the bay (Cuppens & Vogel 2004). The saliña of Rif-Sint Marie rests on the Curaçao Lava formation which harbors three different vegetation types in the area. A *Sesuvium salina* vegetation type is commonly found on the north and west sides of the saliña, where it is subjected to limited flooding and consists of low herb vegetation consisting of mainly halophilic species (Beers et *al.* 1997).

The reef flat adjacent to Boka Sint Marie shelters luxurious coral communities which cover more than 50% of the bottom (MJA Vermeij & VF Chamberland, pers. obs.). Furthermore, the coral reefs included in this proposal shelter dense thickets of Elkhorn coral that sustain major ecological processes as gross community calcification and nitrogen fixation. Dense populations of this branching species dissipate wave energy and thus protect the coast (Mumby et *al.* 2008). Elkhorn coral also ensure healthy and productive reefs by providing shelter to an enormous amount of other reef organisms (Gladfelter & Gladfelter 1978), including both adult fish and their juveniles (Nagelkerken 1974). The deeper fore-reef near Boka Sint Marie is characterized by high coral cover and coral communities are dominated by species of the *Montastraea* species complex. *Montastraea* dominated fore-reefs provide shelter numerous other reef species, including herbivores, planktivores and predatory fish (Mumby et *al.* 2008) and are involved in biogeochemical and physical processes, such as community calcification, nitrogen fixation and wave energy dissipation.

The *Sesuvium salina* vegetation type found on both the north and west sides of the saliña is rare on islands in the southern Caribbean. Less than 400 ha of this vegetation type are currently found on Curaçao and is strictly associated to lower central parts of saliñas (Beers et *al.* 1997).

The area is used by several noteworthy bird species, such as the rare endemic Curaçao Barn owl (*Tyto alba*, Palabrua), the Scaly-naped pigeon (*Columba squamosa*, Blauduif), the Crested caracara (*Polyborus plancus*, Warawara) which is listed under CITES Appendix II, the biome-restricted Bare-eyed pigeon (*Columba corensis*, Ala blanca), the American kestrel (Kinikini *Falco*, *sparverius*), the Curaçaoan subspecies of the Caribbean parakeet (*Aratinga pertinax pertinax*, Prikichi) and several herons and egrets (F Mercelina, Uniek Curaçao, pers. comm.). The saliña of Rif-Sint Marie is crucial to maintain viable populations of the Caribbean flamingo during the dry season when the larger wetlands of Venezuela (where part of the population forages) run dry (Debrot & de Freitas 1999).

PROTECTION STATUS

Rif-Sint Marie was given the “Conservation” status in the island’s zoning plan locally known as the EOP (“Island Development Plan”; AB 1995 no. 36), which became effective on May 23, 1997. The conservation destination is attributed to areas with a scientific, historic, cultural or scenic value. The area was recently (August 2012) proposed as a RAMSAR area by the local government. RAMSAR is an international treaty to protect wetlands of special ecological value and is comparable to the UNESCO designation of Willemstad’s historic center.

GENERAL EFFECT OF THE SPILL ON THE ENVIRONMENT

Coastal areas are particularly susceptible to oil pollution. When a large spill drifts ashore, a fraction of the oil may become trapped in sediments and persist, in some cases for years. This is in contrast to conditions in the open sea, where currents and diffusion usually rapidly reduce the concentration of oil. The immediate effects of heavy oiling of the shore zone can be evident by the death of plants and animals due to smothering and toxicity. In the longer term, the effects are more variable and subtle. Key factors influencing the fate of oil on the shore are the porosity of sediments and the wave-erosion activity acting on them. In high energy environments, (such as rocky shores) the stranded oil may coat the rocks and gradually harden by weathering into a tough tarry skin. The oil is gradually removed by wave erosion, although pools of oil are likely to collect in hollows among the rocks, protected by a skin of weathered oil, and may remain for a long time.

On sandy shores, the oil can sink more deeply into the sediments and can remain longer than on bare rocks. Since the oil is mobile in these porous systems, however, some of it is gradually returned to the water, where it is subject to dissipation but may also have lingering toxic effects. Tidal pumping encourages penetration into sediments and sediment grain size controls the rate of penetration. In muddy sediments, penetration is minimal. However, because these are low energy environments with little physical weathering, stranded oil can persist for a long time. Even so, since few organisms live full time in this habitat, risk to the food chain is relatively light.

Tidal flats are broad low-tide zones, usually containing rich plant, animal and bird communities. Oil may seep into the muddy bottoms, with potentially long term impacts to the environment. Mangroves and salt marshes have a wide variety of plant and animal species and are broadly susceptible to disturbance by hydrocarbons. The effect in such systems is usually a severe reduction in population and growth rate. However, there is likely to be some degree of recovery within one generation. This can vary from one year for some marsh grasses to a decade for mangroves. Mangroves have long roots, called prop roots that stick out well above the water level and help to hold the mangrove tree in place. A coating of oil on these prop roots can be fatal. Coral reefs have the highest level of biodiversity of any ecosystem on the planet and are highly vulnerable to spilled oil — both the smothering and toxic effects. Persisting hydrocarbon presence can also have long term impact on the growth of coastal vegetation.

EFFECT OF OILSPILL ON MAGROVES

Near the entrance alone approximately 2.76 hectares of mangroves are severely impacted by the oil spill. Especially the black mangroves (including their recruiting juveniles) seem lethally impacted.

Mangroves are very important to the ecology and the economy of the regions where they occur. Mangroves provide a buffer to inland areas from devastating hurricane winds and deadly storm surges. Mangroves also trap and stabilize sediment. Many birds use mangrove areas as roosting and nesting locations. Finally, many important commercial and recreation (marine)species depend on mangroves for some aspect of their life cycle, as a nursery, shelter, and foraging. The value of ecosystem services afforded by mangrove forests is estimated at over US$100,000 per square kilometer in American Samoa and US$3.5 million per square kilometer in Thailand. Assuming similar values for Jan Kok (merely as an example as the true value might be higher in this case) and assuming a 20yr recovery period, the damage to the mangroves near the entrance alone would amount to $552.000 under the most optimistic scenario. A rough estimate yields that the true surface of mangroves affected by the oil might be 5-6 times larger, yielding an estimated damage equivalent to $3Million for damage to mangroves alone.

Oil impacts to the mangrove community can vary depending on the type of oil, the amount of oil, and the duration of weathering. Light, refined oils such as gasoline, jet fuel, and No. 2 fuel oil contain relatively high amounts of the most water soluble and toxic compounds in oils. The rich assemblages of plants and animals that are attached to the underwater portion of the prop roots are especially vulnerable. These oils generally evaporate rapidly and thus impacts occur mostly when large spills rapidly strand onshore. No. 2 fuel oil tends to be more persistent, particularly if it penetrates the substrate through animal burrows or trampling by responders. Light fuels are also absorbed by the tree roots and can cause mortality in 24-48 hours in red mangroves and black mangroves. Crude oils and heavy refined products such as Bunker C can coat the prop roots and pneumatophores, reducing the ability of the tree to exchange gases. These heavy oils will have long -term persistence, especially with heavy accumulations. This long term persistence may cause leaf loss and possibly death to heavily oiled trees. Recruitment of seedlings into the oiled area will also be affected.

Mangroves are the most sensitive shore- line habitat to oil spill effects. They are slow growing, sensitive to oil, and difficult to clean. They usually grow in low energy environments where oil can persist for years. These areas should receive the highest protection priority during a spill. Every effort should be made to minimize the amount of oil that is allowed to enter a mangrove area, without causing greater harm.

EFFECT OF OILSPILL ON OTHER ORGANISMS

Additional damage occurred to other ecological values of the area such as the flamingo population, the land crab populations, various other water birds, other land animals etc. Furthermore, long term impacts are suspected to the marine life inside the bay that is likely affected (though the ectend is unknown at this point) and will have long-term ecological consequences.

WHAT TO DO?

Heavy accumulations of liquid oil can be flushed with low pressure (<10psi) flooding. Flushing should be only used on an ebbing tide, with the appropriate collection devices in place. Often there is no access, limiting the use of flushing. This technique should not be used if there is sediment disturbance or mixing of oil into the substrate. Mangrove environments often have a wrack line along the high tide and storm lines. If this wrack becomes oiled it can be a source of chronic sheening and should be removed. Care must be taken not to disturb the substrate. Vegetation should never be cut or removed. Natural Recovery: When clean-up activity causes more environmental damage than the oil, natural recovery should be considered. It is the preferred method for lighter fuels such as gasoline and jet fuel. Natural recovery should also be considered when heavy products are located deep in the mangrove forest or when removal causes mixing with sediments. The placement of sorbents is often used to recover sheens released during natural removal.

DATA FROM: CARMABI, UNITED STATES COAST GUARD (USCG) AND UNITED STATES ENVIRONMENTAL PROTECTION AGENCY (EPA)

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