Electronic Supplementary Material

ESM_1. Site descriptions and ranges of salinity for sampled lakes and wetlands

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Food algae for Lesser Flamingos: a stocktaking

by

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Table 1. Sampling sites. Salinity range according to Hammer (1986): fresh (0.5 ppt), subsaline (0.5-3 ppt), hyposaline (3-20 ppt), mesosaline (20-50 ppt), hypersaline (>50 ppt).

Country **Site**	**Surface area [km^2]**	**Depth-Range [m]**	**Salinity-Range**	**Comments**	**References**
Kenya					
Lake Bogoria N 00°13´83´´, E 36°05´55´´	30 - 42	8 - 12	meso - hypersaline	Steep basin, ±stable hydrology	Harper et al. (2003), Jirsa et al. (2013), Oduor & Schagerl (2007), Onywere et al. (2013), Tebbs et al. (2013b)
Bogoria Hot Springs N 00°13´33´´, E 36°05´41´´	0.002	<0.05	sub - hyposaline	Chemurkeu Area	Krienitz et al. (2003), Owen et al. (2004), Renaut et al. (2013)
Lake Nakuru S 00°21´88´´, E 36°03´46´´	10 - 55	<0.5 - 3.5	hypo - hypersaline	National park, Shallow basin, unstable hydrology	Jirsa et al. (2013), Vareschi (1978), Vareschi & Jacobs (1985), Schagerl & Oduor (2008), Ong'ondo et al. (2013)
Sewage Oxidation Pond S 00°18´17´´, E 36°05´31´´	0.025	<0.2 - 1	fresh	Watering into the L. Nakuru	Kotut et al. (2010)

Lake Elmentaita S 00°27´34´´, E 36°15´33´´	1 - 25	<0.3 - 3	hypo - mesosaline	Shallow basin, unstable hydrology	Melack (1988), Ballot et al. (2004), Schagerl & Oduor (2008)
Lake Magadi S 01°58´09´´, E 36°15´26´´	50 -120	<0.5 - 5	meso - hypersaline	Southern lagoon near hot springs	Brown & Root (1971), Coe (1967), Eugster (1970), Schlüter (1993)
Lake Naivasha S 00°45´24´´, E 36°17´07´´	100 - 170	4 - 7	fresh	For comparison with L. Oloidien, no flamingo site	Verschuren (1999), Harper et al. (2002, 2011), Krienitz et al. (2013c)
Lake Oloidien S 00°49´00´´, E 36°15´52´´	4 - 6	7 - 8	sub - hyposaline	Crater lake, temporally connected to L. Naivasha	Verschuren (1999), Verschuren et al. (2000), Krienitz et al. (2013b)
Lake Simbi S 00°22´19´´, E 34°37´53´´	0.25-0.30	21 - 24	hyposaline	Crater lake, 2 km distant from Lake Victoria shore	Finley et al. (1987), Melack (1979), Ochumba & Kibaara (1988)
Lake Sonachi S 00°46´59´´, E36°15´36´´	0.15 – 0.20	5 - 6	hyposaline	Crater lake, 2 km distant to lakes Oloidien & Naivasha	Verschuren et al. (1999), Melack et al. (1982), Ballot et al. (2005)

Lake Turkana N 03°14′41′′, E 36°02′00′′	6,500	max. 109	subsaline	Largest lake in the Kenyan part of the Rift Valley	Kolding (1992)
Tanzania					
Lake Big Momela S 03°13′33′′, E 36°54′31′′	0.9	max. 31	mesosaline	Arusha National Park, lake frequently visited by Lesser Flamingos	Hecky & Kilham (1973), Kilham & Hecky (1973), Melack & Kilham (1974), Tuite (1981), Lugomela et al. (2006)
Lake Small Momela S 03°13’19’’, E 36°53’30’’	0.5		hyposaline	No flamingos	Hecky & Kilham (1973)
Tulasia S 03°12’44’’, E 36°54’26’’	0.2		mesosaline	Few flamingos	Hecky & Kilham (1973), Tuite (1981)
Burunge S 03°52’39’’, E 35°51’43’’	40		Hyposaline	Vicinity of Tarangire National Park, irregularly flamingos	Mlingwa & Baker (2006)

Lake Manyara S 03°43′43′′, E 35°44′45′′	410 - 480	<0.2 - 4	hyposaline	National Park, high cyanobacterial diversity	Yanda & Madukla (2005), Fyumagwa et al. (2013), Kihwele et al. (2014)
Lake Makat, Ngorongoro S 03°11′50′′, E 35°31′′35′′	3 - 12	<0.5	hyposaline	Shallow lake within the Ngorongoro crater conservation area	Hecky & Kilham (1973), Melack & Kilham (1974), Tuite (1981), Hanby & Bygott 1998
Lake Natron S 02°10′37′′, E 36°04′58′′ S 02°34'04'', E 35°54'38''	81 - 804	<0.1 - 3	meso - hypersaline	Only breeding place of Lesser Flamingo in East Africa	Eugster (1970), Tebbs et al. (2013a)
Uganda					
Lake Katwe S 00°08′20′′, E 29°53′15′′	2.5	1 - 2	hypersaline	Crater lake, mainly chloride, salt (NaCl) production	Mungoma (1990), Pomeroy et al. (2003)
Lake Nyamanyuka S 00°05′27′′, E 29°59′19′′	0.9	n.d.	mesosaline	Crater lake, mainly carbonate-chloride,	Mungoma (1990), Pomeroy et al. (2003)

				important bird area	
Lake Bagusa S 00°06′10′′, E 30°10′24′′	0.35	n.d.	mesosaline	Crater lake, mainly sulphate-chloride, important bird area	Mungoma (1990), Pomeroy et al. (2003)
Botswana					
Makgadikgadi (Sua) Pan, Nata Bird Sanctuary S 20°20′16′′, E 26°14′55′	16,000 (3,400)	n.d.	mesosaline	Largest salt pan of the world	Eckardt et al. (2008), McCulloch et al. (2008)
Namibia					
Flamingopan 1, Etosha North S 18°31′27′′, E 15°55′49′′	0.02	0.3	hyposaline	Flooded temporarily	Berry (1972)

Flamingopan 2, Etosha North S 18°30′24′′, E 15°54′39′′	0.02	0.3	hyposaline	Flooded temporarily	Berry (1972)
Ekuma River Mouth, Etosha S 18°38′19′′, E 15°59′38′′	n.d.	<0.5	hypo - mesosaline	River delta, watering into Etosha Pan	Berry (1972)
Okondeka Spring, Etosha S 18°59′39′′, E 15°52′05′′	n.d.	<0.10	hyposaline	Contact spring, watering into Etosha Pan	Osborne & Versfeld (2004), Dadheech et al. (2013)
Springbockfontein, Etosha S 18°56′13′′, E 16°41′51′′	n.d.	<0.6	hyposaline	Waterhole fed by contact springs at southern shore	Osborne & Versfeld (2004)
Sewage outfall ponds, Walvis Bay (SOW), pond 1 S 22°58′59′′, E 14°31′13′′	0.8	0.15	hyposaline	Birds paradise, good example to create flamingo habitats	
SOW, pond 2	0.002	0.1	mesosaline	Small but fine habitat for	

S 22°58′07′′, E 14°31′48′′				cyanobacteria	
SOW, pond 3 S 22°58′02′′, E 14°31′49′′	0.005	0.1	hypersaline	Despite close vicinity to pond 2, completely different algal settlement	
Lagoon, Walvis Bay S 22°58′40′′, E 14°29′49′′	2.1	0 - 2.5	mesosaline	Tidal mudflats,flamingo spectacle under urban conditions	Wearne & Underhill (2005), Simmons et al. (1999)
Salt evaporation pond, Walvis Bay S 22°59′17′′, E 14°25′12′′	0.005	0.1	mesosaline	One of the largest solar evaporation facilities in Africa	Wearne & Underhill (2005)
Salt and Guano Company Swakopmund (SCS) S 22°34′19′′, E 14°31′27′′	n.d.	0.5 - 1	mesosaline	Diverts water from the sea into the evaporation ponds	
SCS, evaporation pond 1	0.005	0.1	mesosaline	Despite clear water body, flamingos find food sediment	

(clear) S 22°35´11´´, E 14°31´49´´				diatoms	
SCS, evaporation pond 2 (green) S 22°35´48´´, E 14°31´51´´	0.05	0.2	hypersaline	Despite dense algal bloom, no flamingo is eating	
South Africa					
Kamfers Dam S 28°39´34´´, E 24°45´44´´	5	<1.5	hyposaline	World`s only artificial breeding island for Lesser Flamingos	Anderson (2008), Anderson (2015), Anderson & Anderson (2010), Hill et al. (2013)
River Vaal, Barkly West S 28°33´29´´, E 24°31´17´´	n.d.	n.d.	fresh	For comparison with Kamfers Dam, no flamingo site	
India					

Little Rann of Kutch, Nesting Site N 23°20´, E 71°27´	5,000	0 - 1	sub - hypersaline	Unique inundation system seasonally inflow of seawater or freshwater	Singh et al. (1999), Gupta & Ansari (2012), Thomas et al. (2012)
Little Rann of Kutch, Saltpond 1 N 23°21´, E 71°25´	0.001	0.5	subsaline	Part of salt production	
Little Rann of Kutch, Saltpond 2 N 23°19´, E 71°34´	0.001	0.3	mesosaline	Part of salt production	
Little Rann of Kutch, Creek at southern shore N 23°08', E 70°52'	n.d.	n.d.	hypersaline	Diverts water to the Kutch	
Dam near Lake Sambhar	0.005	~1	mesosaline	Scenic mix of flamingos and "civilisation" (temple,	

N 26°57', E 75°18'				railway, rubbish dump)	
Lake Sambhar N 26°55', E 75°10'	190 - 350	0 - 3	hypersaline	Salt pan with high diversity of saline water habitats	Baid (1968), Kulshreshtha et al. (2011)
River Ganga, Varanasi N 25°17', E 83°00'	n.d.	n.d.	fresh	Stream collects microphytes from the flood plain during rainy season	Pandey et al. (2014)

Characteristics of sampling sites

Soda lakes in East Africa

Kenya

The key characteristic of soda lakes is the high concentration of Na^{+} and the low concentration of Ca^{2+} and Mg^{2+} (Grant 2004, see also for more details of typical ionic composition of all Kenyan soda lakes). High contents of carbonate and hydrogen carbonate lead to extreme pH exceeding values of 10. Most of the endorheic soda lakes in this country are located in depressions on the floor of the Eastern (Gregory) branch of the Great African Rift Valley. Lakes **Nakuru** and **Bogoria** are in the centre of interest hosting temporarily the highest population densities of Lesser Flamingos to numbers of about one million in the first years of our study. According to the Waterbird Census Report of the National Museum of Kenya in the period 2001-2009 the number of Lesser Flamingos oscillated between 1,450,000 and 200,000 with highest densities of individuals at the two lakes mentioned. In the subsequent years the numbers decreased considerably. Lake Nakuru, located in the Lake Nakuru National Park, is shallow (mean depth <0.5-3.5m), and in the second half of 2009 it was nearly dried out (salinity 62 ‰, Kaggwa et al. 2013a). Starting end of 2010, the surface area of 31.8 km^2 was flooded up to 54.7 km^2 in September 2013 and increased by 71.9 % (Onywere et al. 2013) and was still so elevated in 2015. The salinity dropped drastically in this phase from 50.7 to 3.9 ‰ (LK, unpubl. data). Because of its depth and the high edges of the basin Lake Bogoria National Reserve, is considered as one of stablest lakes in this area regarding hydrology, chemistry and food web (Harper et al. 2003, Tebbs 2013b). However, in 2013 Bogoria was also affected by flooding and its surface area extended by 26.3 % from 32.6 to 41.1 km^2 (Onywere et al. 2013). The salinity decreased from 47.1 to 20.3 ‰ ; although this was not so dramatic as in Lake Nakuru, the food web responded by radical changes (LK, unpubl. data). For characterisation of the food web and environmental factors in lakes Nakuru and Bogoria, before the floodings, a number of papers was published on geochemistry (Jirsa et al. 2013), on *Arthrospira* and physical and chemical characteristics (Kaggwa et al. 2013b), on phytoplankton with focus on *Anabaenopsis* (Krienitz et al. 2013a), on ciliated protists (Ong'ondo et al. 2013), and on Lesser Flamingos abundance and their diet (Kaggwa et al. 2013a).

Beside the both lakes itself, we studied two adjacent ecosystems which are in close connectivity to the lake ecosystems of Bogoria and Nakuru: i) The hot springs at the shoreline of Lake Bogoria are an important source of recharging lake water (McCall 2010). These springs flow directly into the lake and are visited by the flamingos regularly for drinking water and washing their feathers because of the lower salinity. Temporarily, the hot springs hosted toxic cyanobacteria (Krienitz et al. 2003). Extraordinary high diversity of cyanobacteria in these hot springs was revealed by 454 sequencing and metagenomics. Numerous new and endemic phylotypes were detected which could have the potential to influence the lake biocoenosis (Dadheech et al. 2013). ii) The sewage oxidation ponds of Nakuru town from which water is diverted through a rivulet into Lake Nakuru were also studied. These oxidation ponds are located in the Nakuru National Park and characterized by nearly fresh water supporting a high diversity of cyanobacteria, green algae and euglenophytes. Due to the occasionally observed cyanotoxins produced preferably by *Microcystis* in the sewage ponds, the lake ecosystem is threated (Kotut et al. 2010).

The other soda lakes in the Kenyan Rift Valley support a lower number of Lesser Flamingos in comparison to Nakuru and Bogoria. However, especially in phases when the flamingos left the two core lakes, some tens or even hundreds of thousands of Lesser Flamingos can be observed at the other lakes. Lake **Elmentaita** is shallow (mean depth <0.5-3 m) and smaller (surface area about 20 km^2 with extreme changes) and was well studied in the 1970s by Melack (1988). More recently, together with lakes Nakuru and Bogoria several phytoplankton studies were conducted at Elmentaita (Ballot et al. 2004; Oduor & Schagerl 2007; Schagerl & Oduor 2008). The microbial diversity of the Lake Elmentaita including cyanobacteria was investigated by Kachiuru (2009) using molecular tools.

Lake **Magadi** is a large salt pan divided into several lagoons. The water regime in the different lagoons depends on mixing of three types of water: (i) dilute, cold, bicarbonate-rich river water, (ii) saline, hot, bicarbonate-rich ground water, (iii) saline, cold, carbonate-chloride enriched surface brine (Eugster 1970). Depending on the season and precipitation, most of the Magadi lagoons are dried out and covered by sodium sesquicarbonate ($Na_2CO_3 \cdot NaHCO_3 \cdot 2\ H_2O$, trona) which is used for industrial soda ash production by the Magadi Soda factory. The trona accumulated during the last 6,000 years covers an area of about 75 km^2 and is locally over 40 m thick (Eugster 1970). Saline-alkaline hot springs discharge into alkaline lagoons from around the lake margins constituting the main water source for the lake's endorheic basin. Calculations revealed that springs transport nearly 300,000 m^3 water and 4,300 tons of soda per day into the lagoons (Coe 1967). In 1962, the largest breeding event of Lesser Flamingos was observed at Magadi. About 1.1 million eggs were laid and >350,000 chicks reared (Brown & Root 1971). However, flamingo breeding was never successful again in recent time at Magadi.

Lake **Oloidien** is a caldera of a crater with the shape of a truncated cone and is closely connected to the freshwater Lake Naivasha. Paleolimnological studies covering a time span of ~ 1870 – 1991 revealed that the water level of the lake fluctuated between 19 and 4 m while conductivity varied between ~ 0.250 and 14.0 mS cm^{-1} (Verschuren et al. 2000). Consequently, lakes Naivasha and Oloidien experienced periods of being one or separate water bodies. From 1980-2013 decreased lake levels led to a separation of Lake Oloidien from Lake Naivasha. In April 2013, enhanced water supply by precipitation and possible inflows from the ground induced connection of both lakes. In 2015, again the lakes were separated, however, the lake level is still high (maximum depth 9 m, surface area ~ 500 ha). Because of sub- to hyposaline conditions, the phytoplankton of Oloidien differed in the study period considerably from Lake Naivasha (Krienitz et al. 2013c) and supported in 2006-2012 a flamingo population of 10,000-200,000 individuals (Krienitz et al. 2013b). In the phase of fusion with Naivasha, freshwater and fishes (*Tilapia*) penetrated into Oloidien and caused a drastic change of the food web.

Two kilometers away from Oloidien an other crater lake is located, Lake **Sonachi**, which was subject of detailed ecological (Melack et al. 1982) and palaeolimnological studies (Verschuren et al. 1999). More recently, during our study phase, the phytoplankton was investigated by Ballot et al. (2005). It was shown that the lake was undergoing dramatic changes in phytoplankton dynamics and resulting food web structure. Consequently, flamingo populations were observed only occasionally.

Lake **Simbi** is a scarcely studied crater lake in the vicinity of Lake Victoria. Melack (1979) investigated the photosynthetic rate of an unialgal mass develepment of *Arthrospira* in this lake. Finlay et al. (1987) focused on ciliated protozoa. Ochumba & Kibaara (1988) documented an interesting thermal regime combined with the development of a chemocline. Ballot et al. (2005) reported on toxic cyanobacteria in the lake.

Lake **Turkana** is the largest saline lake on the territory of Kenya. The northern part is located in Ethiopia. Kolding (1992) provided a detailed compilation on characteristics and biology of the lake. It is noted that in comparison to other African subsaline lakes, Lake Turkana has only a low primary production despite strong mixing, and high irradiation. However, nitrogen is considered as the main limiting factor. In Ferguson's Gulf, the abundance of nitrogen-fixing cyanobacteria is higher than in the open water (Kolding 1992). During our study period, the lake was accessed only once at the mouth of the Ferguson's Gulf near Kalokol.

Tanzania

In Tanzania several very important flamingo habitats are located, however, most of them, vainly awaiting ecological investigations (Mlingwa & Baker 2006). In the Arusha National Park, seven small alkaline lakes, the **Momela** lakes, differing in size and character, are located at the slope of

Mount Meru. Limnological analyses were conducted end of the 1960s at some of these lakes, focusing on geochemistry (Kilham & Hecky 1973), diatoms (Hecky & Kilham 1973), and photosynthetic rates of phytoplankton (Melack & Kilham 1974). In the Momela lakes, the highest number of Lesser Flamingos, 220,000, was observed in 1992, and in 2002, the year of our first sampling 17,404 were counted (Mlingwa & Baker 2006). We studied the mesosaline lake Big Momela which was the only lake at our sampling date with a noteworthy number of Lesser Flamingos reaching several thousands of birds. In 2015, additinally, we sampled at lakes Small Momela (hyposaline), and Tulasia (mesosaline).

The large hyposaline Lake **Manyara**, has a surface area of 410-480 km^2 and a mean depth of 3 m (Yanda & Madulu 2005). A first impression on physical and chemical characteristics and related phytoplankton pattern on this important lake ecosystem was published by Kihwele et al. (2014). This lake hosted the highest number of Lesser Flamingos ever counted in Tanzania: 1,940,000 (in 1991), 8,264 (2002), and 382,500 (2004) (Mlingwa & Baker 2006). A clear relationship of enhanced *Arthrospira* abundance and high numbers of Lesser Flamingos with 640,850 individuals in August 2008 was evidenced (Kihwele et al. 2014).

The hyposaline lake **Burunge** irregularly hosts flamingos, highest number counted was >70,000 in 1994 (Woodworth et al. 1997; Mlingwa & Baker 2006). However, actually, the lake attracts more flamingos, reported by the guides of the Lake Burunge Tented Camp during our sampling in October 2015 when we detected numerous flamingo feathers at the shoreline. The lake is fed by the Tarangire river coming from the Tarangire National Park. Lake Burunge is situated outside the National Park directly at its north-western borderline. Until now, the lake was never studied from a limnological point of view.

On the bottom of the Ngorongoro crater the shallow salt lake **Makat** is located, which is temporarily the home of some thousands of flamingos (Hanby & Bygott 1998). It was also subject of the classical limnological investigations of Hecky & Kilham (1973) and Melack & Kilham (1974).

The brine of Lake **Natron** makes this habitat to the « world’s most caustic body of water » (Tebbs et al. 2013a). Often, and especially in the centre of the lake the brine is coloured red due to extremophilic bacteria. In comparison to the adjacent Lake Magadi, Lake Natron is larger and shallower, has smaller catchment and evaporation areas and do not possess such a thick trona layer suggesting the saline character evolved more recently (Eugster 1970). Furthermore, two rivers contribute to inflow of water in the Natron basin, Ewaso Ng'iro in the North, and Engare Sero in the South. Because of its shallowness and extreme evaporation the shape of the lake is permanently changing and each lagoon is different in physical and chemical characters. Lately acquired data showed the minimum extend of the surface with 81 km^2 (October 2000) and the maximum with 804 km^2 (March 2007) (Tebbs et al. 2013a).

Lake Natron is the only breeding site of Lesser Flamingos in East Africa and essential for propagation of this treatened bird. The major part is located in Tanzania whereas a small northern portion lies on the territory of Kenya. Unfortunately, this Ramsar (Convention on Wetlands of International Importance) habitat is not protected by law of the two countries and several proposals for industrial exploitation are under controversial discussion (Childress et al. 2006). A project is envisaged about building a dam on the river Ewaso Ng'iro, a major inflow into the lake coming from Kenya for hydroelectric power generation. International protests hampered a project to built a soda ash factory at Lake Natron (Baker 2011). Cost-benefit analysis demonstrates that mining of soda ash at Lake Natron is not economically viable (BirdLife International 2012, Kadigi et al. 2014). The water level is a key regulator of breeding activities of Lesser Flamingos. The level must be high enough to discourage predadors but low enough to enable to built the nests. The highest number of Lesser Flamingos observed was 750,000 in 2007 (Tebbs et al. 2013a). In the 1990s, three times numbers of >370,000 were counted at Lake Natron (Mlingwa & Baker 2006). Later, in the 2010s, the numbers never exceeded 100,000 birds (Clamsen et al. 2011).

Uganda

Lake **Katwe** (250 ha) is an alkaline crater lake with extreme concentrations of salts near to saturation point. It is located in close vicinity of the Queen Elizabeth National Park, between the large freshwater lakes Edward and George and is used for salt extraction from its sediments. Two other crater lakes, **Nyamanyuka** (90 ha, but can completely dry out), **Bagusa** (35 ha), lay in the same area but have lower salt content. The three crater lakes were characterized by Mungoma (1990), and Pomeroy et al (2003). The authors classify Katwe and Nyamanyuka as lakes with few flamingos, whereas Bagusa belongs to the lakes with many flamingos reaching numbers to 15,000. Regarding the limno-chemistry the lakes belong to three different categories depending on domkination anions: carbonate-chloride (Nyamanyuka), sulphate-chloride (Bagusa), and chloride (Katwe) (Mungoma, 1990).

Saline wetlands in southern Africa

Botswana

The **Makgadikgadi** Pan in Botswana is a huge saline wetland covering about 16,000 km^2. The lowest and for flamingo breeding most suitable region of this wetland is the Sua Pan with 3,400 km^2 surface area (McCulloch et al. 2008). Its hydrology and chemistry is strongly influenced by cycling and interaction of the different compounds such as soil leachates, fresh river water inflow, salty lake surface water and subsurface brines (Eckardt et al. 2008). An additional influence is given by the activities of the factory « BotAsh » using the brine for production of NaCl, Na_2CO_3, Na_2SO_4 and $NaHCO_3$ salts. The hydrochemistry is varying widely in the different areas of the pan. At the flamingo sites Na^+ considerably excesses Mg^{2+} and Ca^{2+}. Generally the hydrochemistry of the Makgadikgadi Pan is comparable to other saline wetlands in southern Africa such as the Etosha Pan but differ from East African soda lakes by lower concentration of $NaHCO_3$ and higher content of Cl^- (Eckardt et al. 2008). Comparison of hydrochemistry and crustacean plankton at different salinity ranges of the Makgadikgadi Pan was conducted (McCulloch et al. 2008). The highest ever observed numbers of fledged chicks of Lesser Flamingos were >30,000 in 2000 (McCulloch 2004), and 30-35,000 in 2010 (Flamingo 2011).

Namibia

The **Etosha** Pan, is a hyposaline wetland of > 4,500 km^2 size (Osborne & Versfeld 2004). When the water at remote places of this huge area is on suitable levels, Lesser Flamingos can breed at the pan (Berry 1972; Simmons 1996; Simmons et al. 1999). Salinity values vary considerably depending on evaporation. Therefore, water sources with lower salt content such as springs are essential for the survival of the numerous animals in the Etosha National Park (Osborne & Versfeld 2004). Even flamingos are coming occasionally to drink and wash the feathers at the outlets of springs. The pans conductivity ranged between 26 and 67 mS, whereas at the mouth of the inflowing river Ekuma (whereto the fledged chicks were trecking from the nesting site through a distance of 90 km) a conductivity of 1.9-45 mS was measured. This information was taken from the first detailed report on breeding of Lesser Flamingos at Etosha Pan in 1971 when >30,000 chicks were grown (Berry 1972). This study includes measurings on the colonies and nests and behaviorial studies of the birds, as well as analyses on physical and chemical characteristics and food algae. Calculations in the 1990s revealed in Namibia about 93% of Lesser Flamingos occurrence in southern Africa. However, the breeding success at Etosha Pan was very low estimated by 0.04 surviving chick per pair. Consequently, Etosha was rated as nonviable breeding site (Simmons 1996).

In addition to the flamingo hot spot at Etosha, Namibia is blessed with flamingo habitats at the seaside where the birds preferably dwell in phases when the wetlands at Etosha dried out. However, when the rains come to Etosha, the flamingos respond promtly and fly the 500 km from the coast to the pan in one night (Simmons 1996). Walvis Bay is a town with >85,000 inhabitants at the central Namibian coastline of the Atlantic ocean surrounded by desert landscape. The town is harboring the country's only deep water port and several industrial settlements such as for fishing and fishprocessing, shipyards, cargo enterprises, manufactoring of accessories for housing and transport, and the guano and salt industry of the region which is important for setting up artificial wetlands for the flamingos.

Around Walvis Bay several waterbird habitats of international importance are located (Simmons et al. 1999). An area of 9,000 ha of the marine wetland is declared as Ramsar site. The **Walvis Bay Lagoon** is a sheltered inlet from a bay of the ocean forming interdidal mudflats. Twice a day, the tides flush the lagoon with nutrient rich seawater supporting development of phyto- and zooplankton. This food sources attract both Lesser and Greater Flamingos in about equal numbers. In the period 1997-2005 the maximum numbers of each of these two species exceeded 43,000 individuals (Wearne & Underhill 2005).

Salt evaporation ponds of the Walvis Bay Salt Refiners cover an area of 3,500 ha and represent one of the largest solar evaporation facilities in Africa, processing 24 million t of sea water each year to produce more than 700,000 t of high quality salt (http://www.walvisbaycc.org.na/?page_id=71). In contrast to the lagoon, the salt ponds do not undergo diurnal fluctuations. However, due to the pumping of the seawater from one pond to the next, there is a great variation of salinity in the different ponds, and some of them establishing suitable conditions for food algal growth of the flamingos. Furthermore, at the periphery of Swakopmund a guano and salt company built a network of different evaporation ponds attracting flamingos.

The centrepiece of Walvis Bay **Bird Paradise** is a series of ponds artificially formed by discharge of liquid waste from the sewage works of the municipality. The sewage outfall ponds create a variety of water bodies used by many birds as stop over and feeding ground (http://www.birdsparadise.net/).

South Africa

Kamfers Dam, a former ephemeral pan near the diamond town Kimberley, inundated only occasionally, was transformed by the municipality into a sewage disposal site in the 1970s. Consequently, the nature of the wetland was turned into a perennial water body. High nutrient load led to mass developments of *Arthrospira* which was the base of a more or less permanent population of Lesser Flamingos starting to built nests near the shore of the dam. However, breeding attempts were not successfully . Naturalists of South Africa under the guidance of Mark Anderson developed the idea of an artificial, 250 m long breeding island (Anderson 2008). The Lesser Flamingos accepted this offer and produced 24,000 chicks between 2007 and 2009 (Anderson & Anderson 2010) and earned enthusiastic international recognition. Unfortunately, due to heavy rains and especially by increasing sewage water inflow, rising water levels flooded the island in the subsequent years and interrupted the breeding activities. The dilution also led to a considerably decrease of salinity. The dominating salt in the dam is sodium chloride, highest observed salinity was 2.22 mS in 2005, lowest 0.65 mS in 2011 limitating the growth of *Arthrospira* (Hill et al. 2013). Strong controversies between the environmentalists and the administrators of the town and the sewage plant, even at the High Court, resulted in a compromise to protect this habitat of « Pink Diamonds ». The sewage plants efficiency to process the waste water of the expanding town was improved. Furthermore, a portion of the waste water will be diverted outside the catchment area of Kamfers Dam into the river Vaal’s flooding drain (Anderson 2015). Kamfers Dam hosts the majority of

Lesser Flamingos in South Africa with numbers of 20 – 80,000 birds (Childress et al. 2008). The water quality of this light house project of the national and international flamingo conservationists is under regular control by the Water Quality Consultancy Bloemfontain (Roos 2012).

In order to evaluate the potential of the catchment area to introduce other cyanobacteria and algae into the dam we studied a sample from the river Vaal. This river collects outflows from the catchment and accommodate potential primary producers which could invade also into the dam and could there under certain conditions establish mass developments.

Saline wetlands in India

Little Rann of Kutch is a monotonous flat plain (5,000 km^2), closely associated to the Great Rann of Kutch (7,500 km^2) in Gujarat. This salt marshes are connected to the Gulf of Kutch, an inlet of the Arabian Sea. In ancient time, the Kutch was part of the oceanic floor and has been lifted slightly above sea level during Pleistocene. Little Rann of Kutch is characterised by a unique inundation regime receiving seasonally saline water from the sea by storm tides as well as freshwater from the landside by monsoon runoffs. The ground of the plain is covered by a variety of halite, gypsum, clay and sands (Gupta & Ansari 2014). The chemical composition is characterised by high concentrations of Na^+ and Cl^-, mid-levels of Mg^{2+}, and by missing of carbonates and hydrogen carbonates which makes the main difference to the African soda lakes. The concentration of NaCl in the Little Rann of Kutch is 5-6-fold higher in comparison to seawater (Thomas et al. 2012). Here, 25% of the Indian salt production takes place. The Little Rann of Kutch is a Sanctuary of the Indian Wild Ass and represents the largest wildlife reserve in India. Laying on the cross roads of migration streams of birds and equipped with unique characteristics combining sea-, freshwater- and dryland-habitats, this area harbors a great variety of avifauna. Lesser Flamingos found remote places for breeding at the Little Rann of Kutch (Singh et al. 1999). The highest numbers of nests ever observed was about 5,000 in 2009 (Parasharya 2009). However, breeding success is vague because of the drastic hydrological regime with strong monsoon rains on the one hand and relentless drying out on the other hand.

Lake **Sambhar** is the largest salt lake of India (up to 350 km^2) situated at 364 m above sea level in a depression on the foot hills of Aravalli Mountains in an arid region of Rajasthan. Extreme evaporation led to strong accumulation of NaCl. The lake water is alkaline and contains NaCl, Na_2SO_4, Na_2CO_3 and $NaHCO_3$. However, the content of soda is lower than in the lakes of East Africa. Its salinity is changing drastically between 9.6 – 164 ‰ depending on season and hydrology (Baid 1968). A dam is dividing the main lake in the West from the reservoir zone with numerous evaporation ponds of the salt works in the East (~80 km^2). The Sambhar salt industry is the largest in Rajasthan. After the monsoon rains in July/August, from the main lake water is diverted to the salt ponds. These ponds have strong differences in salinity and biota. In some of the ponds edible algae perform intense growth and attract Lesser Flamingos with different success. The lake is a Ramsar site because of its importance as overwintering area of migrating birds from northern Asia and as refugium of flamingos (Kulshreshtha et al. 2011). In the catchment area of the lake several smaller water bodies of different character are situated and can also act as flamingo feeding ground, especially after the monsoon rains, when the salt concentration is not too extreme. All these waters need to be studied in order to compare the ecological conditions and the potential for support of the flamingos.

For comparison of the algal flora of the salty wetlands with that of a freshwater we took a sample from River Ganga in Varansi after the rainy season. The 2,525 km long Ganga is the second largest river of India and belongs to the most polluted rivers of the world. Pandey et al. (2014) characterised the river near Varanasi. However, due to strong seasonality, the river experiences also phases of good algal growth after monsoon rains which wash nutrients and microphytes from the land and waters of the flood plain. Generally, the alluvial soil transported into Ganga has a high natural fertility (Pandey et al. 2014).

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