Ramsar Advisory Mission No. 76

Mývatn-Laxá region, Iceland (2013)

Ramsar Site N° 167

Mission Report

by

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19 – 23 August 2013

Contents

Acknowledgements

Hildur Vésteinsdóttir organised the logistics and meetings for the Mission at short notice and despite many summer holiday absences. Those involved who contributed their time, knowledge and information are listed on page 12.

The representatives of *Landsvirkjun*, the national power company, provided much information in an open and cooperative spirit to the Mission core team (Guðríður Þorvarðardóttir, Ólafur Jónsson, Hildur Vésteinsdóttir, Tobias Salathé) and contributed to their effective work in a minimum of time available. They, and all other experts, are thanked for their constructive contributions to find sustainable solutions.

Summary and Recommendations

1. Lake Mývatn and its outflowing Laxá river form an outstanding wetland ecosystem in the Arctic realm. Thanks to the geothermal water inflow with specific mineral loads, a rich food web, leading to an outstanding biodiversity, has been able to develop rapidly since the creation of the ecosystem after a major volcanic eruption 2,300 years ago. The Mývatn-Laxá Protection Area is highly valued by the Icelandic society for its outstanding and unique biodiversity values, for its hydrological services and the substantial recreational and tourist attraction the landscape and its features provide locally, nationally and globally. The Mission therefore highlights the outstanding importance of this wetland ecosystem and acknowledges the global commitment by Iceland, when joining the Ramsar Convention, to sustainably manage this heritage for the benefit of future generations, according to the Ramsar "wise use" principle.

2. Ramsar Contracting Parties have agreed[1] to provide up-to-date information to the Ramsar Secretariat on the status of their Ramsar Sites, their ecological character and how the Ramsar Site area was defined. Therefore, Iceland is requested to provide rapidly an updated Ramsar Site Information Sheet (RIS) and Map for the Mývatn-Laxá region to the Secretariat, following the guidance provided in Handbook 17 on designating Ramsar Sites (4th. edition 2011), given the fact that the most recent information dates from 1992 and that the delineation of the Ramsar Site boundary and its surface are not sufficiently described. The Mission notes that updated RIS are also needed for the Þjórsárver and Grunnafjordur Ramsar Sites.

3. The Mission acknowledges that the Mývatn-Laxá wetland ecosystem harbours outstanding biodiversity and provides essential ecosystem services in a typical Arctic environment, notably due to its volcanic origin and geothermal resources. Because it is a highly dynamic and unpredictable ecosystem, human interventions need to be planned carefully, according to the "precautionary principle". Because an impressive amount of monitoring data, research and studies were accumulated, undertaken and analysed over the last ten years in many different environmental fields, the experts met by the Mission agreed on the utility, and indeed the very need to update the original environmental impact assessment (EIA) with a complementary study.

4. The complementary EIA needs to thoroughly assess the likelihood that the expanded borehole operations and geothermal fluids and steams and their processing and waste water overflows alter groundwater temperature, composition and flows to Lake Mývatn, in the short and long term, and to show what ecological impacts this would be likely to have on the current lake vegetation, food webs and fauna. In view of the planned enlargement of the geothermal power plant at Krafla, the complementary EIA should also analyse the possible combined or accumulated effects of enlargements at both places.

5. Unfortunately, the Mission could not meet an expert on the effects of hydrogen sulphide emissions on human health, and cannot provide more details on this subject. However, the complementary EIA study should also cover in more detail the issue of hydrogen sulphide emissions (current and foreseen) and their consequences on the human and natural environment. This should be usefully complemented by an assessment of natural emissions of CO_2 (a greenhouse gas) and its release caused by the activities linked to the possibly extended geothermal plant (as suggested in the Efla report). The Mission requests therefore that such a complimentary environmental impact assessment be undertaken.

[1] Initially through Resolution VI.13 in 1996, and reiterated since at each meeting of the COP, most recently through Resolution XI.4 in 2012 on the current status of Ramsar Sites.

6. Before permits are granted for the extension of the power plant, the Mission suggests that the authorities request the development of operational scenarios providing guidance on how to prevent non-recoverable substantial changes in the lake ecosystem because of human interference (such as the chemical water composition and temperature, as the basis for the food web), and how to cope with, and react to indicators from the regular monitoring of key parameters that announce possible non-reversible changes to occur. Such operational scenarios could be considered a practical application of the "precautionary principle".

7. Possible changes induced by an extension of the Bjarnarflag and Krafla power plants are not the only factors which might affect the water quality of Lake Mývatn. The Mission observed local agriculture becoming more intense, in terms of fertilizer use and livestock densities in the water catchment and in the immediate vicinity of the lake shores. The Mission also observed an increasing number of guesthouses and hotels close to the lake, which would increase the possibility of sewage overspills from septic tanks into the lake. These trends merit an analytical study to anticipate further developments and their likely impacts on the lake and river ecosystems. The results of such an analysis should be ready in time to develop and implement avoidance, mitigation or compensation measures, according to Ramsar Resolution XI.19 which provides an integrated framework and guidelines for avoiding, mitigating and compensating for wetland losses.

8. The Mission notes the desirability for the Iceland authorities to establish rapidly a national wetland/ Ramsar committee which can address water and wetland-related issues at national and local scale through an integrated, inter-sectoral approach to develop sustainable and widely agreed solutions.

9. The Mission notes with pleasure the impressive knowledge, expertise and capacities available in Iceland to cope with and manage water and wetland-related development and conservation issues, and the important role Iceland could therefore play in wider regional fora in the Arctic and Nordic-Baltic area in this field, notably in the framework of the Ramsar Convention and its NorBalWet regional cooperation mechanism, and by facilitating Ramsar's cooperation with the Arctic Council's working group on the Conservation of Arctic Flora and Fauna, and its secretariat in Akureyri.

Ramsar Mission members Hildur Vésteinsdóttir (left), Ólafur Jónsson and Bergþóra Kristjánsdóttir on lava spills at the southern shores of Lake Mývatn (all photos taken by T. Salathé on 21 August 2013).

Introduction and purpose of this report

10. Article 3.2 of the Ramsar Convention states that "Each Contracting Party shall arrange to be informed at the earliest possible time if the ecological character of any wetland in its territory and included in the [Ramsar] List has changed, is changing or is likely to change as the result of technological developments, pollution or other human interference. Information on such changes shall be passed without delay to the organization or government responsible for the continuing bureau duties specified in Article 8", i.e. the Ramsar Secretariat.

11. The Ramsar Convention gives special attention to assisting Contracting Parties in the management and conservation of listed wetland sites whose ecological character is changing or likely to change. This is carried out through Ramsar Advisory Missions, a technical assistance mechanism adopted through Recommendation 4.7 by the 4th meeting of the Conference of the Contracting Parties in 1990 (formerly known as the Monitoring Procedure and the Management Guidance Procedure). The main objective of this mechanism is to provide assistance to countries in solving the problems at particular Ramsar Sites related to the maintenance of their ecological character.

12. The Ramsar Secretariat received information from different sources about ecological change likely to occur at Ramsar Site N°167 Mývatn-Laxá region in Iceland, stemming from possible pollution and run-offs from a planned geothermal power plant, due to a planned dam on the River Laxá and to diatomite mining activities. And more precisely, on 28 September 2012, two Icelandic non-governmental organisations, the *Landvernd* (Icelandic Environment Association) and *Fuglavernd* (BirdLife Iceland), submitted a substantiated report to the Ramsar Secretariat on their concerns about likely impacts on the lake ecosystem provoked by the planned extension of the Bjarnarflag geothermal plant.

13. Based on this information, the Ramsar Secretariat requested further information from the Environment Agency of Iceland on 31 October 20122 and proposed that an on-site Ramsar Advisory Mission could look into these issues. The general director of the Environment Agency and its Ramsar national focal point responded to the Ramsar Secretariat in a letter of 19 April 2013 and clarified "that plans to dam the River Laxá have been cancelled by *Landsvirkjun*, the national power company, and the diatomite mining from Lake Mývatn was ceased in 2004". Regarding the planned geothermal power plant in Bjarnarflag, they stated that "there is some uncertainty concerning possible effects of waste water run-off and airborne pollution from hydrogen sulphide. The main issues regarding waste water run-off are due to chemical contamination, possible cooling of the geothermal areas and changes in silica flow to Lake Mývatn, but silica is one of the main bases of the biosphere of Mývatn." And they invited the Ramsar Secretariat to look into this issue during an on-site visit in Iceland.

14. In consultation with the Ministry for the Environment and Natural Resources, the Ramsar Advisory Mission was subsequently planned and jointly undertaken by a core team from the Ministry for the Environment and Natural Resources (Guðríður Þorvarðardóttir), the Environment Agency (Ólafur Jónsson, Hildur Vésteinsdóttir) and the Ramsar Secretariat (Tobias Salathé), benefitting from the support and contributions of additional experts, as listed at the end of this report.

Overview of the Mývatn-Laxá Ramsar Site

15. The Ramsar Site (or "Wetland of International Importance") consists of the shallow, eutrophic Lake Mývatn (c.3,700ha), incised by numerous inlets and creeks and dotted with about 50 islands and islets, its outflowing Laxá river, stretching about 59km downstream to its mouth on Skjálfandi bay at Iceland's northern Atlantic shore, and a large marsh complex surrounding the lake. These habitats together form the Mývatn-Laxá Protection Area. The first protected area was originally established in 1974 and covered in addition a large part of the upstream groundwater catchment basin of Lake Mývatn. However in 2004, the Protection Area was substantially reduced to cover a new surface of 15,323ha. The Ramsar Site

[2] The Environment Agency of Iceland is the administrative authority designated by the government to be responsible for Ramsar implementation in Iceland.

includes in addition to this Protection Area an important part of the upstream water catchment on an extensive plateau with the Sellandafjall and Bláfjall hills (of which 263,508ha are designated as a water protection area). The Ramsar Site covers an area of about 20,000ha.

16. Lake Mývatn was formed only 2,300 years ago through a major volcanic eruption. Its larger, southern basin lies in a shallow depression of an extensive lava field that also shapes the surroundings. Precipitation water is quickly absorbed into the bedrock and surfaces as spring water. Ytriflói, the northeastern smaller part of Lake Mývatn, close to the Bjarnarflag/Námafjall geothermal area (see below), is essentially fed by thermal groundwater springs, while Syðriflói, the southern part of the lake, is fed by cold groundwater springs. The lake water is rich in minerals, which is the main reason for the fertility of the lake. Important growth of diatomite and green algae provides the basis for an exceptional food web, including at higher trophic levels midges *Chironomidae*, crabs, fish (including a population of Arctic Char *Salvelinus alpinus* of economic interest) and birds. A peculiarity of the lake is the presence of large green algal balls *Aegagropila linnaei*, up to 10-12cm in diameter, which are only known of this size from Lake Mývatn and Lake Akan in Japan. So far, their functions in the ecosystem are little understood. Large parts of the lake bottom are covered by thick diatomaceous sediment layers, stemming from the remains of the abundant siliceous unicellular diatomite algae.

17. River Laxá flows from Lake Mývatn to the Atlantic in parallel natural channels with small cascades among richly vegetated islets. It is among the best Brown Trout *Salmo trutta* and Atlantic Salmon *Salmo salar* fishing rivers in Iceland. Together with Lake Mývatn, it is particularly important for two, otherwise North American, duck species. The many blackfly larvae *Simulium vittatum* and non-biting midge larvae *Chironomidae* in the river and lake provide essential food support for the sedentary population of about 1,700 individuals of Barrow's Goldeneye *Bucephala islandica* that account for 95% of the total Icelandic population, and for about 400 individuals of Harlequin Duck *Histrionicus histrionicus* that live concentrated in this area (representing 2.6-4.5% of the Icelandic population). An impressive number of additional waterbird species breed and also rest in the area, among them some that are rarely found elsewhere in Iceland, such as the ducks Common Scoter *Melanita nigra* and Gadwall *Anas strepera*.

18. Besides Lake Mývatn and the Laxá river, the Ramsar Site supports freshwater marshes, ponds and rivulets with a rich submerged flora, birch (*Betula pubescens* and *B. nana*) woodlands, extensive wet grasslands, fens and peat bogs. The abundant invertebrate fauna and the habitat diversity provide undisturbed space and food resources for a large numbers of nesting waterbird species and moulting ducks.

19. In 1975, the Mývatn Lake Research Station was established following the passing of the Mývatn-Laxá Conservation Act in 1974 by the legislative assembly of Iceland (*Alþingi*) to provide on-site study facilities for this unique and complex ecosystem of international interest. The Mývatn Research Station is run by the Ministry for the Environment and Natural Resources in cooperation with the University of Iceland. Much research and many monitoring studies have since been undertaken and published. They made this wetland ecosystem one of the better known in the world. In addition, the *Mývatnsstofa* information centre in Reykjahlíð offers a modest, but modern exhibit on the lake's ecology, documentation and practical information to the many guests and tourists passing by (essentially in summer).

Maintaining the ecological character and the ecosystem services of the Mývatn-Laxá Ramsar Site

Human activities in and around Lake Mývatn with possible effects on its ecological character

20. Despite its overall "natural" appearance, and a very low human population density in the area, the Mývatn-Laxá lake and surroundings have been impacted and modified by human interventions for centuries, and increasingly so during the second half of the 20th century. Human activities in the Ramsar Site and its surroundings include farming, fishing, hydro- and geothermal electricity generation, and tourism. The human population around Lake Mývatn increased over the last hundred years, evolving from a mainly agricultural community (sheep and cattle rearing, with increasing fertilizer use and spread of cultivated land since the 1960s) to one focused more on tourism.

21. In 1967, industrial mining of the diatomaceous sediments started in Ytriflói, the northern basin of Lake Mývatn, using suction dredging methods. A refinery was set up close to the lake at Bjarnarflag[3] to produce, with chemical procedures using sulphuric acid and sodium carbonate, about 22,000 tonnes of diatomite per year. In 2004 this industrial mining was stopped.

22. At the Námafjall ridge, about 3km from the shores of Lake Mývatn, sulphur was mined since old times with a peak extraction of 37 tonnes/year in the early 19th century. This was finally abandoned in 1952.

23. In 1971 a central heating system was installed after the drilling of nine boreholes (down to -1300 m) in the Bjarnarflag geothermal area. Hot borehole water overflow to the lava fields and groundwater temporarily created a substantial rise in the temperature of some spring waters. The geothermal water rapidly clogged the central heating system and septic tanks for household wastewaters with silica deposits. Thus, the heating system was changed to make use of geothermal steam to heat up cooler, less mineralized groundwater.

24. On River Laxá, three hydro-electric plants were built between 1939 and 1973 with a total capacity of about 27MW. To assure their functioning and to maintain the water level of Lake Mývatn, dams and control gauges were constructed on the river outlets from the lake. They now control the river flow to some extent.

25. In particular, the industrial dredging of diatomaceous sediments in Lake Mývatn was considered a threat to the ecological character of the ecosystem. Following a debate on this subject in a special session of Ramsar's 4th meeting of the Contracting Parties (COP4 in Montreux 1990), a first Ramsar Advisory Mission visited the Mývatn area on 25-30 June 1992, invited by the Icelandic authorities. In their final report (publicly accessible here), the mission experts recognized the importance of the ecosystem, acknowledged its high biological productivity and complexity, and noted a substantial decline in the numbers of Arctic Char, a decrease in duck populations, and the disturbance of bottom sediment and a loss of macrophytic plants in the area of the diatomite excavation. Consequently, they urged the Icelandic government to apply the "precautionary principle" when taking a decision on the prolongation of diatomite mining in the Ramsar Site. Eventually, the mining in the Ytriflói basin of the lake was formally ended in 2004 and the refinery closed, because of economic reasons.

26. Currently, the Iceland Environment Agency (*Umhverfisstofnun*) supervises the implementation of a Management Plan 2011-2016 for the Mývatn-Laxá area. The plan puts a strong emphasis on decreasing any stress factor to the ecosystem.

27. In 2013, the Environment Agency published a "Red List" of protected areas, i.e. areas in danger of losing their protection value and those which had already lost it at least partially. The Mývatn-Laxá area figures in this list with the following reasons given: a) uncertainty about impacts on the lake ecosystem by the planned Bjarnarflag geothermal power plant, b) only 2% of the original population of green algal balls are remaining in the lake, c) sludge from septic tanks is still deposited in the lake, and d) increasing numbers of tourists are causing increasing pressure on the ecosystem.

Partial view of the existing Bjarnarflag geothermal plant, its waste water retention pond (left) and Lake Mývatn in the background.

[3] For the location of geographical locations mentioned in the text, see the web-based map of Iceland at www.map.is.

A possible new threat - the Bjarnarflag power project

28. The current situation can be summarized as follows: In the Bjarnarflag geothermal area, about 3km from the northeastern shores of Lake Mývatn (i.e. the Ytriflói basin), a 3MW geothermal power plant has been operating since 1969. And in the nearby Krafla geothermal area (some 15km from the lake), also inside the lake water catchment basin, a 30MW plant has been operating since 1978, with an additional 30MW turbine added in 1997. Waste water from both plants flows into surface retention ponds and from there into the groundwater. Groundwater is known to flow from both areas into Lake Mývatn. At the Krafla plant, since 2002 part of the waste water has been re-injected into the underground geothermal reservoir. Both plants are operated by *Landsvirkjun*, Iceland's main power generating company (producing in 2012 about 72% of the electricity in Iceland). *Landsvirkjun* operates 13 hydropower plants in Iceland (with a combined capacity of about 1,800MW); Krafla and Bjarnarflag are its only two geothermal plants (63MW).

29. *Landsvirkjun* has announced substantial extension plans: it considers Bjarnarflag as one of the best studied geothermal areas in Iceland (for more than 50 years) and plans to replace the outdated power plant from 1969 with modern equipment and to add to the six existing hot water drills (with a potential production capacity of 40MW) two more, to increase the power production capacity to 45MW, planned to be operational by 2015. Afterwards, a second phase of the Bjarnarflag plant extension would double the power production capacity to 90MW. In 2003, an environmental impact assessment was undertaken for the planned extension to 90MW capacity. In addition, *Landsvirkjun* announced its plans to build a second power plant at Krafla with a capacity of 135MW, and to enlarge the current plant at Krafla by another 40MW.

Possible change of the ecological character of Lake Mývatn through power plant waste water inflow

30. The main environmental concern with regard to the Ramsar Site is about the waste water runoff from the geothermal plants. *Landsvirkjun* states in its Environmental Report 2012 that excess water (i.e. "condensed and separation water"), subsumed here under the term "waste water" from geothermal power stations contains heavy metals and nutrients, the source of which is partly from geothermal fluid, and a result of corrosion in the machinery used. The natural concentration of these substances varies between areas and is contingent upon volcanic activity and groundwater flow. High concentrations of these chemicals can have an impact on the ecosystem.

31. It is known that underground currents carry groundwater from the Bjarnarflag area to Lake Mývatn. Waste water flowing from the current Bjarnarflag plant into porous soil and groundwater contains various substances in higher concentrations than the groundwater entering Lake Mývatn. *Landsvirkjun* published the quantities of heavy metals, nutrients and gases contained in its Bjarnarflag waste waters and released into surface waters. They include carbon dioxide, hydrogen sulphide, arsenic, silica, iron, aluminium, copper, chromium, nickel and zinc in a decreasing quantitative order. The extension of the Bjarnarflag plant could triple the substance load of its waste water flow from 50kg/s to 180kg/s. Local studies using chemical tracers have so far shown contradicting results about the thinning effect during the water flow between Bjarnarflag and Lake Mývatn. However, in its annual reports to the Environment Agency, *Landsvirkjun* provides results of independent monitoring of the waste water effluents from the Krafla and Bjarnarflag stations, showing that the concentrations are so far within the legally accepted environmental limits.

32. In 2002 *Landsvirkjun* begun to re-inject waste waters into the geothermal reservoir at Krafla. The aim of such re-injection is to maintain pressure in the geothermal reservoir and to reduce environmental impact. For the Bjarnarflag extension project, *Landsvirkjun* announced in a meeting with local stakeholders in July 2012 their plan to re-inject all waste waters into circumscribed underground compartments (200-500m deep), underneath the groundwater currents that flow to Lake Mývatn.

33. The Ramsar Mission was, however, not provided with substantial information on this procedure, and has no information that would allow a clear assumption that re-injected waste waters can be securely kept separate from groundwater flowing into Lake Mývatn. Ecological experts in Iceland fear that a

consequence of re-injecting waste waters may be the cooling of the natural groundwater flows. Most of the lake's silica, sustaining the rich growth of diatoms and the food web of the ecosystem, is carried to the lake by geothermal water originating in the Bjarnarflag area. Because silica concentration increases with temperature, cooling this groundwater can result in lowering the content of solved silica in the water entering the lake. No plans on how to mitigate the effects of such a situation were presented. So far, monitoring data on groundwater flow, temperature, silica concentration and pressure are available only for a situation without substantial waste water re-injection. The groundwater monitoring data collected at Bjarnarflag represent the existing situation, with only a small operating plant of 3MW production, without re-injection of waste waters.

Possible change of the ecological character of Lake Mývatn through increased hydrogen sulphide air pollution

34. It is anticipated that the concentration of hydrogen sulphide (H_2S) in the air will increase as a consequence of the additional emanations through the planned extension of the Bjarnarflag geothermal plant. *Landsvirkjun* stated that they would be willing to install pollution control equipment to their boreholes, if required to do so by the authorities, and as long as this would not affect the economic viability of their power production project.

35. Many Icelanders and foreign visitors (c.100,000 people/year) enjoy their bath in the steaming geothermal waters of the Mývatn nature baths at Bjarnarflag next to the power plant, and believe in its curative effects (e.g. for skin diseases). However, hydrogen sulphide is also considered a toxic gas that irritates the eyes, lungs and respiratory tract. And some evidence exists of adverse health symptoms in communities who are exposed to long-term low levels of hydrogen sulphide in the environment of geothermal areas.

36. Current levels of hydrogen sulphide concentration in the air have been monitored in the nearby settlement of Reykjahlíð since 2011, at least occasionally. So far the legal limit in Iceland of 50µg/m^3 daily average has never been surpassed (the World Health Organization recommends a less stringent limit of 150µg/m^3). Two additional air quality monitoring stations were installed in May 2013. Often, local thermal inversions of the air layers cause the geothermal steam emanating from the boreholes and from natural fumaroles, rich in hydrogen sulphide and other gases, to be trapped at low altitude over the human settlements. Thus, further studies on environmental effects on human health are envisaged.

37. Besides this, it is rather unclear at this stage, whether and how increased hydrogen sulphide concentrations in the air could have specific consequences on the Mývatn lake ecosystem. Currently, it is not expected that the oxidation of hydrogen sulphide into acid rain would become a problem at Bjarnarflag.

The regulatory context

38. An initial environmental impact assessment (EIA) was undertaken in 2003 for the proposed project to expand the Bjarnarflag power plant to a capacity of 90MW. Based on this EIA, the National Planning Agency (NPA) accepted the project on 26 February 2004 with the following specifications on monitoring and surveillance to be organised by *Landsvirkjun*:

    - to conduct monitoring on the temperature in the geothermal system, boiling conditions, diminished flow from drilling wells and changes in chemical contens in drilling fluids;

    - to conduct area surveillance and monitoring concerning changes in the geothermal system and its surrounding environment, including chemical content in hot springs and fumaroles, changes in temperature level on surface, changes in ground elevation and gravimetry, seismic and gas measures, and geothermal mapping;

- to monitor potential influences of geothermal exploitation on chemical content and fluids of the warm groundwater flow to Lake Mývatn by measuring chemical content and temperature and water levels in wells and fractures. If there are alterations, mitigation actions need to be established.

39. Through the studies undertaken earlier and published in relation with the EIA of 2003, and thanks to the further monitoring undertaken in the follow-up of the NPA ruling in 2004, there is substantially increased data, knowledge and understanding of the groundwater and geothermal water flows in the area now, ten years later.

40. The development licensor needs to request a decision from the NPA on whether the developer's EIA needs to be revised, in whole or in part, if the proposed development does not commence within ten years of the ruling by the NPA on the EIA. Thus, *Landsvirkjun* asked the consulting firm *Efla* to review the EIA from 2003 and to consider the need to revise it. A few weeks after the Mission, when the results of this review were ready, its summary report (in Icelandic) was sent to the Ramsar Secretariat.

41. The *Efla* report states in its English summary that the conclusions from 2003 regarding land use, noise, landscape and geological formations, vegetation, fauna, cultural remains, visual impacts and effects on outdoor recreation and tourism are still valid ten years later, taking into consideration changes that have occurred during this period with regard to the natural baseline conditions, environmental legislation, international commitments and technological development or design for geothermal plants. The report also considers that the negative effects on the air quality will remain below the limits set by national regulations and the operational permit, at least as long as *Landsvirkjun* is willing to look into better alternatives for the release and purification of gasses.

42. Regarding waste waters, the *Efla* report states that "in terms of effects caused by geothermal fluids, the likelihood of effects occurring in Lake Mývatn is negligible and a new EIA is therefore not considered necessary. Existing data show that the geothermal fluids dilute fast and extensively. According to surveillance measurements carried out by *Landsvirkjun* in connection with release due to current activities in the area, geothermal fluids from the activities cannot be detected in the inflow to Lake Mývatn or in the lake." *Efla's* assumption of "negligible effects" is only corroborated with data referring to the current activities of the geothermal plant with a capacity of 3MW. No meaningful forecast is provided for possible effects of the activities of a planned plant of 90MW capacity.

43. Therefore, significant uncertainties of possible changes to groundwater temperatures, composition and flows to Lake Mývatn, as a consequence of additional boreholes, increased geothermal water abstraction, and re-injection and seepage of geothermal waster waters into groundwater flows remain.

44. Since the original EIA was made, a considerable time elapsed and significant new information regarding geothermal water abstraction and re-injection was gained with other geothermal plants in Iceland. Thus, the Environment Agency had suggested that this part of the original EIA of 2003 needs to be revised. This suggestion from the Minister of Environment and Natural Resources, Sigurður Ingi Jóhannsson, was also publicly broadcast by the national RÚV television and radio company on 21 August 2013.

Implementing the Ramsar Convention in Iceland

45. The Ramsar Advisory Mission was also an opportunity to address other issues relevant for Ramsar implementation in Iceland in discussions with the administrative authority, i.e. the Environment Agency, and the Ministry of Environment and Natural Resources.

46. Iceland showed an early interest in wetlands and joined the Ramsar Convention as its 21st Contracting Party on 2 April 1978, thus following rapidly the 18 initial states which signed the agreement during the inaugural conference in the city of Ramsar on 3 February 1971. When depositing its instruments of accession to UNESCO on 2 December 1977, Iceland designated the Mývatn-Laxá region as its first Ramsar Site. This was a clear sign of the wide acknowledgment of the uniqueness and the outstanding

importance of this ecosystem already at the time. On 20 March 1990, Iceland designated its second Ramsar Site, Þjórsárver, the upper part of the Þjórsá river with its tundra meadows, marshland and pools. And on 24 June 1996, the coastal bay Grunnafjörður with is mudflats and river estuary was listed as the third Ramsar Site.

47. The information submitted on these Ramsar Sites dates from the time of their designation, or was updated in 1992. Contracting Parties are requested to update Ramsar Site information on a rolling basis, whenever a change concerning the information submitted in the Ramsar Site Information Sheet (RIS) occurs, or to submit regular updates at least every six years. Information on these three Ramsar Sites needs therefore to be updated as a matter of urgency, and be submitted to the Ramsar Secretariat in the currently valid format of the RIS which can be found on the Convention's website. A video guidance on how to update Ramsar Site information is available here.

48. On 18 February 2013, Iceland made a significant move, well noticed at global level, and added three more Ramsar Sites to its national list. Adding the Snæfells- og Eyjabakkasvæðið glacier forelands and tundra floodplains, the Friðland í Guðlaugstungum tundra fens, mires and shrublands, and the Andakíll coastal mudflats and meadows increased the wetland ecosystem diversity of Iceland's listed sites significantly. The Andakíll Protected Habitat Area in the Borgarfjörður estuary shows in an innovative way how local agricultural interests in wet grasslands (grazing areas and fodder producers for domestic livestock) can lead to the development of modern management practices which also take into account the use of the grasslands as refuelling sites by migrating geese. Andakíll provides an interesting case study to illustrate the slogan "Wetlands and agriculture: partners for growth" of World Wetlands Day 2014 (2 February).

Mudflats and coastal grasslands of the Andakíll Ramsar Site in western Iceland.

49. A possible future scoping study at national scale, responding to Ramsar' strategic framework for the further development of the Ramsar List (detailed in Ramsar's Handbook 17), may provide guidance on identifying the most representative sites of the relevant wetland types to be considered for additional Ramsar listing. Wetland types with outstanding examples at global scale in Iceland are likely to include Arctic peatlands, extensive glacier forelands and tundra floodplains, coastal areas important for sea mammals and birds, and geothermal springs and related wetlands.

50. The Environment Agency and Ministry announced during the Mission that they are considering setting up a national Ramsar committee, to serve as an inter-ministerial think tank, clearing house and coordinating body to facilitate the preparation and implementation of sustainable policies for land and water resource uses, possibly to be supported by a specific national wetland policy, or adequate consideration of wetland ecosystems in national biodiversity, water resources or land use policies and action plans.

51. The Mission noted with satisfaction the extensive wetland knowledge, expertise and data available in Iceland, and how effectively different sectors are accustomed to working together on environmental and sustainable development issues. This capacity and its modern infrastructure put Iceland in an excellent position to become more active at international level for wetlands and the Ramsar Convention.

52. Iceland, as an active member of Ramsar's NorBalWet initiative for regional cooperation in the Nordic-Baltic region, substantially supported by the Nordic Council, has an opportunity to reinforce the work on Arctic wetlands, by focusing particularly on their ecosystem services in relation to climate change effects and their roles in supporting Arctic biodiversity with many global links, such as those illustrated by Arctic breeding birds spending most of their time migrating across the globe.

53. Furthermore, Iceland is in an excellent position to play a crucial role in furthering the cooperation between Ramsar and the Arctic Council's working group on the Conservation of Arctic Flora and Fauna (CAFF) with its secretariat established in Iceland's second largest town Akureyri. Concrete cooperation on shared Ramsar-CAFF matters, including the Iceland Environment Agency and Ministry and the national Ramsar focal points, seems to provide a promising opportunity.

Itinerary and people met

19 August Mr **Tobias Salathé** travels from Gland to *Reykjavík* (via Geneva, Zurich and Oslo).

20 August He meets at the Environment Agency (*Umhverfisstofnun*) with the mission leader
- Mr **Ólafur Jónsson** (director for natural resources),
- Mr **Kristinn Ársælsson** (service department) and
- Ms **Hildur Vésteinsdóttir*** (Ramsar national focal point, in Akureyri, via Skype);

and at the Ministry for the Environment and Natural Resources with
- Mr **Jón Geir Pétursson** (director general for land and natural heritage),
- Ms **Guðríður Þorvarðardóttir*** (land and natural heritage specialist)**,**
- accompanied by Ólafur Jónsson and Hildur Vésteinsdóttir (via Skype).

21 August Flight to *Akureyri* by Ólafur, Guðríður and Tobias, joined there by Hildur; all travel by car to the *Mývatn-Laxá* region and are joined by
- Ms **Bergþóra Kristjánsdóttir*** (nature specialist of the Environment Agency) who guides the mission around Lake Mývatn;

at Reykjahlíð they meet with
- Ms **Guðrún Valgeirsdóttir** (mayor of the Skútustaðahreppur municipality) and
- Ms **Dagbjört Bjarnadóttir** (chairperson of the Skútustaðahreppur municipal administration);

prior to a rapid visit of the *Námafjall* geothermal area overlooking the *Bjarnarflag* power generation site, followed by a short interview with RÚV national television on the southern shores of Lake Mývatn, before traveling back to *Akureyri* and *Reykjavík*;

in the afternoon, Ólafur, Guðríður, Hildur and Tobias travel to *Hvanneyri* and meet at the Agricultural University of Iceland with
- professor Mr **Björn Þorsteinsson** and
- Ms **Ragnhildur Jónsdóttir** (director of the Wetland Center at the Agricultural University of Iceland and farmer at *Ausa*, a farm inside the Ramsar Site)

who show the mission around the new Ramsar Site Andakíll Protected Habitat Area,
then return travel back to Reykjavík.

22 August At the Environment Agency in *Reykjavík*, meetings of Tobias, Guðríður and Hildur with representatives of the *Landsvirkjun* power generation company:
- Mr **Jón Ingimarsson*** (environmental manager, research & development division),
- Mr **Bjarni Pálsson** (power projects manager, research & development division),
- Mr **Valur Knútsson** (Bjarnarflag geothermal power project manager),
- Ms **Björk Guðmundsdóttir** (landscape and planning project manager),
- Mr **Ásgrímur Guðmundsson** (senior geologist) and
- Mr **Hákon Aðalsteinsson** (ecology project manager);

followed by a meeting with **Sigurður Jónas Þorbergsson**, representing the landowners of Reykjahlíð;
followed by a meeting with NGO representatives:

- Mr **Guðmundur Guðbrandsson*** (managing director of *Landvernd*, the Icelandic Environment Association),
- Mr **Jón S. Ólafsson*** (freshwater ecologist, Institute of Freshwater Fisheries, board member of Landvernd and a member of Birdlife Iceland),
- Ms **Holmfridur Arnardottir** (managing director of *Fuglavernd*/BirdLife Iceland) and
- Mr **Péter Villányi** (intern student at *Fuglavernd*);

in the afternoon concluding discussions of the Mission members Tobias, Ólafur, Hildur and Guðríður,

followed by a brief on the mission and Ramsar's priorities for Iceland to

- Ms **Kristín Linda Árnadóttir*** (general director of the Environment Agency and head of the Ramsar administrative authority);

23 August Tobias travels back to Gland (via Copenhagen and Geneva).

The experts marked above with an asterisk (*), and also Mr **Gísli Már Gíslason** (professor at the University of Iceland) provided comments on a draft report and scientific publications supporting the final editing of this report.