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Cover Photo: Bofedal wetlands, Argentina, Jonathan R Stacey, 2009 ©

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Emerging markets for electric engines?

Global markets are tentatively edging towards embracing the new technology that will see the internal combustion engine, with its climate-altering emissions of CO_2 and other pollutants, replaced by electric engines, which will have zero emissions at point of use. Vehicles with zero emissions would seem to be a "no-brainer" for companies, countries, and consumers seeking to reduce carbon emissions and urban air pollution, so why is the market not transitioning more rapidly to this new technology?

Firstly, zero emissions at point of use will not significantly reduce risks to climate change if the electricity being used to charge electric vehicles is generated using a range of fossil fuels such as coal, oil, and gas in the energy production mix. While the burning of coal is diminishing across the developed world, there remains a huge dependence for energy generation across Asia and Africa, where some of the fastest growing economies are located. Continuing dependence on an energy mix that includes oil, natural gas, and coal will also not create carbon-free electric vehicles. Yet a transition to electric vehicles must be seen as a good thing, surely?

Secondly, electric vehicles will only become an effective and competitive alternative when they have sufficient battery capacity to store a charge that can compete with the range provided by current petrol- or diesel-powered vehicles. To achieve this, advanced battery technology will be needed, which will be hugely dependent on lithium. The lightest and softest of metals, lithium is the critical commodity to realising this revolution in transport technology, and many investors are warming up to this relatively young and developing market. The metal has long been known as a primary ingredient for lithium-ion batteries which are key to lightweight, rechargeable power for laptops, smartphones, and a range of other digital devices. Batteries for transport will require a major shift in the global supply and demand of this essential element. Therefore, this transition to battery-powered transport will be dependent on globally accessible sources of lithium, which could be limiting due to the remoteness and scarcity of the resource. The recyclability of lithium is already a challenge, and while advances in this technology are anticipated, this will put greater pressure to access and develop primary reserves of this emerging commodity.

Lithium mining in support of the rechargeable battery market will be perceived as bolstering a "green" technology that promises to realise the transition from fossil fuels to renewable energy. However, can lithium mining maintain a reputation of being a truly sustainable industry, including all aspects of its "cradle-to-grave" supply chain, from mining through production, use, and disposal? The sourcing of much of the world's lithium in the High Andes of South America will provide a test as to how sustainable the life cycle of this new "green" technology can be.

Figure 1. Flamingo in the Lithium Triangle region. Photo credit: Mike Green

The Lithium Triangle

According to the US Geological Survey, the United States has just one lithium mine, in Nevada, while Australia, Chile, and Argentina currently produce the most lithium in the world. Chile is part of the High Andean "Lithium Triangle" encompassing Argentina, Bolivia, and Peru. Both Argentina and Chile increased their lithium production 15 percent each in 2014 alone to meet the growing demand, while globally, lithium production jumped 6 percent that year. As technological innovation improves and investor interest is stimulated, it would appear that lithium extraction could be on the threshold of a development boom, and that this "Lithium Province" is already being targeted.

Rising demand and limited supply have resulted in lithium prices tripling over four years. Already economically-stable Chile hosts some of the leading lithium producers, such as Albemarle Corp. and SQM (Soc. Quimica y Minera de Chile SA).However, these core global producers have seen obstacles to expansion due to social and environmental sensitivities in the region. New junior companies with an interest in entering this market have not yet been able to set up new mines due to complex regulation and opposition from local communities. In Bolivia, which hosts what is considered to be the world's second-largest lithium resource, attempts to expand mining development have largely failed, with only 250 tons produced in 2018. Nevertheless, there are plans to bring Bolivian production capacity to 150,000 tons by 2023.

However, it is in northwest Argentina where much of the interest is currently focussed. According to an Economist Intelligence Unit report, the country appears to be in the early stages of a lithium boom,

with two mines currently in production and over 60 projects in various stages of development, with five close to productive capacity. Investment in lithium projects has increased tenfold in the past six years, according to Argentina's Ministry of Mining Development. Paul Graves, chief executive officer of lithium technology firm Livent Corp., said in 2018 that a changing political and economic climate in the country, with refocussed investment priorities and opportunities, means that business confidence in Argentina is at its highest in 20 years. Livent is associated with mining company FMC Corp., which has been operating in Argentina for decades from its lithium mine at Salar del Hombre Muerto in Catamarca Province. It was here that I had first-hand experience of FMC's lithium mining activities when I visited this incredibly remote region in 2009, as part of an international effort to survey the breeding and feeding sites for Andean and Puna flamingos.

Figure 2. Breeding site for Puna flamingos. Photo credit: Jonathan R Stacey

Mining and Flamingos – can we avoid a collision?

While lithium extraction may be promoted as good for the environment and for particular economies, we are already aware that there are likely to be negative impacts associated with the development of this sector in the region. The fate of South America's iconic flamingos may well be on a collision course with an impending lithium boom resulting from the world's transition to electric vehicles. While this energy transition might be heralded as an environmental triumph, the "devil is in the detail". It is important to pay attention to the range of environmental and socio-economic risks that may be associated with this potentially overwhelming development opportunity for Argentina and the region.

The Altiplano region, also known as the Puna region, of Argentina, Bolivia, Chile, and Peru is the only region in the world where two species of High Andean flamingo breed and feed. Andean Flamingo (*Phoenicoparrus andinus*),James's Flamingo (*P. jamesi*), and Chilean Flamingo (*Phoenicopterus chilensis*), are three species of flamingo which are found in the high *salares* (salt flats), internal

drainage basins surrounded by the some of the highest volcanoes on Earth. Over millennia, the activity and the weathering of these Andean volcanoes has produced the lithium deposits that are now concentrated in these salt flats, and which are the prized commodity fuelling the emerging energy revolution.

Figure 3. Lithium mining evaporation ponds. Photo credit: Felicity Arengo

Modern mining has already impacted the breeding flamingos of this remote desert region. It was the development of one of the world's largest copper mines in Chile that raised the profile of Andean Flamingo sensitivity to mining development. BHP (then known as BHP-Billiton), the largest diversified mining company in the world, manage a joint venture copper mining operation (with Rio Tinto) at Minera Escondida in the Atacama Desert of northern Chile. One of the water sources crucial to this mine's operations is the Salar de Punta Negra, known to be a critical breeding location for Andean Flamingo. Glaciers on nearby Llullullaico – at 6,739m (22,110 ft), the second highest volcano on Earth – feed groundwaters that generate springs at the Salar de Punta Negra. To mitigate water abstraction from the critically important *salar*, Minera Escondida installed an artificial surface water mixing and recharge system that replenished the lagoons used by Andean Flamingos at this site. Despite a range of efforts to protect the breeding site at Salar de Punta Negra, Andean Flamingos no longer use the site as they once did, but have now dispersed to other *salares* in the region.

Collaboration for Research and Conservation

Rio Tinto, BHP partner company at Minera Escondida, used its then-global strategic partnership with BirdLife International (the world's largest biodiversity conservation partnership) to support the development of a better understanding of how globally threatened Andean Flamingos used their breeding and feeding sites across the region. Over a five-year period (2005-2010), the Rio Tinto – BirdLife International Partnership supported a transnational approach led by the *Grupo para la Conservacion de Flamencos Altoandinos* (GCFA), the High Andes Flamingo Conservation Group. This group is a well-established alliance of flamingo conservationists from the governmental, non-governmental and private sectors, within the four flamingo range countries (Argentina, Bolivia, Chile, and Peru). The group's regional and local work was recognised internationally and attracted significant support from the Ramsar programme in the Americas, from the Wildlife Conservation Society (WCS) and the American Museum of Natural History, so as to better understand flamingo range use and more effectively target and focus management actions throughout these High Andean

wetlands. This support helped the GCFA coordinate its regional research and conservation programmes focused on population monitoring, protection of breeding colonies, and studies of distribution and habitat use, as well as training and outreach activities targeting protected area staff, students, professionals, and the general public. The implementation of all these activities would not have been possible if not for the large network of volunteer collaborators and a diversity of efforts including in-kind support, competitive proposals, and a variety of national and local commitments.

Figure 4. Census of flamingos in the High Puna of Argentina. Photo credit: Jonathan R Stacey

Priority sites for Flamingos

An International Simultaneous Census (ISC) undertaken in 2010 at 259 wetland sites across this four-nation region was a milestone in survey and monitoring effort. This built on previous census efforts initiated between 1997-2000 which are now undertaken at 5 year intervals. These are contributing to a process of developing a clearer understanding of the breeding and feeding distribution of the two globally threatened flamingo species of the High Andes, with a focus on which *salares* were critical for breeding and feeding. This has been followed by a comprehensive census in 2015 with many important sites visited annually, contributing to a robust data set for the region. A further international census is planned for 2020. This data informs a long-term regional conservation strategy aimed at securing the integrity of both key High Andean wetlands crucial to the survival of Andean and Puna Flamingos, with an ongoing goal to establish a regional network of priority sites in the High Andes of Argentina, Bolivia, Chile, and Peru. This data continues to inform the network of Important Bird Areas (IBAs) across the region, as well as the ongoing establishment and expansion of Ramsar sites and other Protected Areas. We now know the most important sites for flamingos within the Lithium Triangle which overlap precisely with areas of high concentration of flamingos. It is these shallow wetlands with the physical and chemical characteristics that concentrate lithium that also produce the diverse microbial, planktonic, and invertebrate communities that support a rich and abundant avifauna.

Furthermore, this ongoing commitment to field survey and monitoring has enabled the GCFA to engage and build trust with a constituency who are aware of the importance of these wetlands and are better informed and equipped to respond to environmental issues.

*Figure 5. Andean flamingo (*Phoenicoparrus andinus*). Photo credit: Felicity Arengo*

Data accessibility

Much of this data is accessible. **Important Bird Areas** – sites identified because they meet clear global criteria for biodiversity importance –are well known in the region, due to the work of BirdLife International and its national conservation partners (e.g. Aves Argentinas). Such data is accessible through the BirdLife Data Zone, but there are other sources of data too, such as e-Bird and the Global Biodiversity Information Facility (GBIF).

Within the Integrated Biodiversity Assessment Tool (IBAT) for Research & Conservation Planning, global sites of biodiversity importance are hosted in formats that are designed to be useful to planners and development organisations. This facility is developed and managed by a consortium of organisations comprising BirdLife International, Conservation International, the International Union for Conservation of Nature, and the UN Environment World Conservation Monitoring Centre; it is made possible by a diverse set of data providers, users, and funders in government, business, and civil society from over 200 countries and territories. Regional initiatives, such as the GCFA in the Lithium Triangle area, add greater detail to these layers of information.

The GCFA has recently updated and issued a report on mining activity in the Catamarca Province of Argentina, a key area within the Lithium Triangle. It continues to monitor and analyse flamingo use at a suite of sites across the region, building toward an International Simultaneous Census for 2020.

It has also prepared a document submitted to the Third Meeting of the Multi-Stakeholder Energy Task Force of the Convention of Migratory Species (CMS) at last year's CBD COP 14 in Egypt.

Such data can be accessed and used to inform a *strategic environmental assessment* for the Lithium Triangle region, to help ensure that developments avoid, and where necessary, mitigate impacts on critical sites for the flamingos of the High Andes. Such a strategic assessment needs to recognise that flamingos in the High Andes are essentially nomadic in their use of a dynamic mosaic of wetlands. It is the collection of priority sites configured in the landscape that is critical to their survival, not just the individual sites. It is also important to recognise that flamingos serve as flagship species for the conservation of wider biodiversity values associated with these wetlands: as habitats for unique microbial communities, plankton, and invertebrate assemblages; as critical wetlands for both migratory, resident, and endemic birds; and for protected mammal species, all dependent on a delicately balanced and potentially fragile hydrology and geochemistry. These are organisms adapted to extreme and variable environments that could be pushed to unknown limits by an unprecedented and potentially irreversible level of disruption for short-term economic gain.

For mine planning, it is the awareness of, and the effective use of, such data that is critical to the process of mainstreaming biodiversity best practices into the extractives sector. This is a theme that was being highlighted in the CBD agenda following the UN Biodiversity CoP14 in Egypt last year, and will continue in the lead-up to CoP20 in Beijing 2020.

Figure 6. Biologists discover young flamingo mortality caused by flooding due to poorly designed mine-road construction across salt flats. Photo credit: Lucila Castro

Inadequacy of the project-specific impact assessment and the need for hydrological modelling on a landscape-scale

While individual mining projects are required to develop and submit project-specific environmental, social impact assessments (ESIA) to secure a permit, there is often limited public access to these assessments. Furthermore, project-specific impact assessments are frequently inadequate in addressing the indirect and accumulative impacts of mineral extraction over time. In particular, the long-term hydrological modelling studies that would provide critical data for assessing the impacts of lithium (or other) mining on the hydrology of *salares* are just not available, and do not seem to be required by project-specific ESIA in some of these countries, with little if no consideration of impacts relating to the levels of water extraction. Furthermore, some countries show little consideration for the Protected Areas status of some sites, despite the availability of such data. The ongoing impacts of climate change and the reduced glacier cover feeding these ground-water reservoirs are also not being considered when permitting mine developments, in regard to their impacts on biodiversity and local communities.

Current research in the Atacama in Chile undertaken by the University of Massachusetts has modelled the Atacama basin, and found negative water budgets where recharge of these groundwaters are less than current evaporation and extraction rates, even where there is no mining. This suggests that the water table was formed thousands of years ago, when the climate was more humid. For the flamingo species using this landscape, while they are adaptable to variable environments and can track resources and choose wetlands that are in the most favourable condition across the Lithium Triangle, eventually they will run out of options if the hydrological integrity of these wetlands is undermined by poorly-informed development and climate-change impacts. In the case of lithium mining, the precautionary principle should be applied, and mining companies should be able to demonstrate that they are not causing any damage, given what we know about the system. However, even so, we do know that lithium mining is already occurring in some Ramsar sites which disregards these sensitivities.

Within such a context it would be far more effective if mine development was permitted through a process of *strategic landscape-level planning* that was informed by ongoing hydrological studies, biodiversity data, mineral resource mapping, and local stakeholder community engagement and input. Governments with a better understanding of the sensitivities would then be in a better position to divert mining and other development to less sensitive areas and to adopt best practice mining approaches.

Figure 7. High altitude wetlands support a diversity of life in the desert. Photo credit: Jonathan R Stacey

Social impacts

It is not just flamingos and other biodiversity that will be impacted by the imminent lithium boom in the Andes. Environmental impacts can underpin social impacts, and yet the development and remit of ESIAs may not be stakeholder-inclusive. Lithium mining, through abstraction and evaporation across the *salares*, can impact groundwater hydrology and the livelihoods of local indigenous communities which have adapted to and are dependent on precious, limited water resources in this arid environment.

Water scarcity has not only led to conflict between the State and mining companies, but also with local communities, where in some instances people have been forced to migrate and abandon their ancestral settlements. Such issues have sparked civil society movements in the region to advocate for the rights of indigenous peoples, for the right to Free, Prior and Informed Consent (FPIC), and the rights to water, land, and self-determination. And there have been legal cases brought to the national and international level, as indigenous groups have fought against companies to protect their rights. The current status of some leading lithium producers on human rights is not particularly reputable in the region . Furthermore, the role of government in consulting local communities can be improved, allowing for better consultation on mining exploration licenses.

With the demand of lithium expected to increase tenfold over the next decade, lithium extraction and its associated social and environmental impacts are expected to rise in this region. Chile is currently leading the way, as it hosts the world's second largest lithium production, after Australia, at established mines that are set to double or triple production. Argentina is sure to follow, currently with two active extraction sites and more than 60 projects under development. Bolivia is lagging behind, but has high ambitions for lithium extraction in the future.

Certified Lithium through impact avoidance and best practice?

Now is the time to plan for *Certified Lithium*. If the industry it supplies is to be acknowledged as an environmental saviour in addressing pollution and climate change, then we need to ensure that its extraction incorporates the best practices in strategic environmental and social impact assessment and planning. The information is available to do so. Such assessments and planning tools can progress alongside the development of technical solutions that aim to avoid and mitigate impacts on the hydrology and biodiversity of these High Andean *salares*. The development and implementation of these tools should be a key concern and requirement of the institutions responsible for facilitating the growth of this emerging sector, such as the Inter-American Development Bank, the International Finance Corporation (IFC), the World Bank, the Equator Banks, and the ICMM (International Council on Mining and Metals). Indigenous communities, and the fabulous flamingos and their critical habitats across the "Lithium Triangle" of the High Andes, fully deserve such consideration and protection.

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