

Colonialism and the Infrastructures of Knowing

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Part 1. Infrastructures in STS

STS tells us that scientific knowledges grow out of more or less messy laboratory, classroom and fieldwork practices. It says that those practices are shaped by and in turn shape power and context. The historical and ethnographic case studies in STS reveal the sheer heterogeneity of what goes into and helps to keep science practices running. These include: *materials* (laboratory consumables, technical equipment, specialist software, IT systems, genetically modified mice, and the fabric of laboratories); trained *people* (scientists, technicians, maintenance, and admin staff); and *documents*, (lab notebooks, data inputs, visualisations, reports, academic papers, grant applications, and patents.) And these all run through and help to form the *organisations, economic arrangements, academic conventions, legal frameworks, and systems of education* that get taken into and help to shape science practices. This combination of the material-and-social is what we mean when we talk about *infrastructures*, and it is the topic of this entry. So, in the way we use this term, infrastructures extend far beyond obvious inputs like electricity or water. They include everything, material and otherwise, that goes into the practices of knowing.

So, what is an infrastructure in this way of thinking? Here are some common STS suggestions (Slota and Bowker, 2017; Joks et al., 2020).

1. They are *inputs that support and afford* practices.
2. They are *material, practical, and embedded in practices*.
3. They are *heterogeneous* because they are different in kind.
4. They mostly work *unnoticed in the background* (becoming visible only when they fail).
5. They are *relations* that have been '*packaged up*'. When they work properly, they seem simple, but in fact they are complex weaves that have been created through (and within) many interlocking practices.
6. This packaging-relation dynamic (sometimes called 'black boxing' (Callon, 1987)) goes on *ad infinitum*. In other words, *infrastructures contain other infrastructures* all the way down. (An example: English language competence is an 'infrastructure' needed to read this encyclopaedia; this in turn depends on an infrastructural education system. Other relevant infrastructures here include the economic and material arrangements for producing and distributing books.)
7. Infrastructures *shape* ways of knowing because it is easiest to know by including and using existing infrastructures. Going against the grain is difficult, and can even lead to conflict (Cardwell, 2015).
8. This means that widespread ways of knowing, their practices, and their infrastructures tend to *marginalise* alternatives (Japanese and Chinese scientists often adopt the language and/or the conventions of dominant Anglophone science, further marginalising possible alternatives and creating even stronger incentives to publish in English (Law and Mol, 2020).
9. But ways of knowing and their infrastructures are contingent and could be *different*. And this in turn reveals that...
10. they are also *political*: which means that alternatives, better or worse, might be imagined, and brought into play.

Many have explored how knowledges are shaped and tend to marginalise alternative ways of knowing. This is implied, for instance, in Thomas Kuhn's (1970) notion of paradigm, and more recent work has explored how this also works in contexts of colonialism. For Linda Tuhiwai Smith (2012) the methods that underpin social science empower some knowledges, and objectify others, denying indigenous groups agency in knowledge creation. Svario Krätli and his colleagues (2015) show how methodological infrastructures in ecology sustain equilibrium modelling and marginalise non-equilibrium alternatives more appropriate to pastoral ways of living (see also (Benjaminsen et al., 2015)); Kim Tallbear (2013) explains how the biological essentialism of DNA science undermines First Nations' understandings of kinship; and Anthony Hatch (2014) discusses how the narrow medical focus of 'metabolic syndrome' forecloses broader discussion of the role of inequality and oppression in poor health. Peter Cole (2002) explores how the conventions of academic writing limit not just the way things are said, but what can be said; while Amâde M'Charek and her colleagues (2020) show how the techniques of forensic science reproduce racial categories even as the notion of 'race' is denied. And Michel Foucault (1970) argued that *epistemes* set limits to what can be known in a given era. These authors are all very different, but the issue, how ways of knowing get to be infrastructurally powerful and marginalise alternatives, is common to them all.

In Section 2 below, we explore these infrastructures of knowing by drawing on two cases. We start with Michel Callon's classic account of the failure to domesticate scallops in Saint Brieuc Bay in France, before moving to a more recent and successful attempt to do so in Scotland. We explore how powerful economic, technical, scientific and political infrastructures shaped each, and then how these were assembled in different ways to generate very different outcomes. Our argument is that infrastructures are powerful, but not all-powerful, and that if they are artfully drawn on and arranged, alternative ways of knowing are possible.

In Section 3 we discuss the deeply embedded infrastructures of coloniality. Here we describe a colonial conflict in north Norway where economic, technical, scientific and political infrastructures are destroying indigenous Sámi ways of knowing salmon. We discuss how scientific knowledge of salmon draws on and reproduces a dominant scientific realism that divides nature from culture in environmental science and management. Drawing from this, our suggestion is that *metaphysical* infrastructures (in the form of taken-for-granted assumptions about the character of reality) become visible in contested colonial contexts. But how can we problematise this realism? Our final case describes an attempt in Newfoundland to do just this by practising a novel marine biology that juxtaposes dominant scientific understandings of nature with indigenous relations to the world. This example shows that other metaphysics are possible if we accept the contingency of what counts as 'reality' and attend carefully to the knowing practices that reproduce such infrastructures.

In Section 4 we briefly summarise the argument by contrasting the overdetermined notion of *social structure* with the possibilities opened up by attending to *infrastructures*. The latter are powerful, but in principle they are also potentially malleable, and this is particularly important in a colonial context.

Part 2. Reshaping Economic, Political, Scientific and Technical Infrastructures

The Scallops and the Fishers of Saint Brieuc Bay

STS tells us that scientific findings are created in practices. Michel Callon (1999) described how three French biologists tried to answer what seemed like a simple question: do the larvae of *Pecten maximus* (a scallop species) anchor to solid surfaces? He showed that this research was socially shaped because they wanted to increase the breeding rate of economically valuable scallops. But he also argued that the scientists were not just creating knowledge about nature that reflected social agendas but were also reshaping the social world. He said, in short, that the social and natural were inextricably woven together, and that to practise science was to *rework both*. So, the experiment was about weaving a new infrastructure in which scallop larvae would anchor, grow, and become commercially valuable, so transforming them from largely unknown entities at risk of overfishing into tractable, predictable and fishable beasts. For this to work new webs of relations were needed. Scallop larvae had to anchor themselves to newly created collectors; predator starfish had to be kept off; ocean currents needed to be controlled so the larvae didn't wash away; and fishers needed to be kept away too. But none of this was easy. Did the scallops attach to the collectors? Sometimes they did, often they didn't. The reasons for this were unclear, but a whole bevy of actors (currents, parasites, depth, water temperature, and others unknown) were identified as potentially complicit. Even so, there was some success, and for a while this new web held together. Until, one night, a small group of fishers invaded the protected area, fished out the scallops, and broke the collectors. The scientists had assumed the fishers would respect the conservation of scallops, as it benefited them in the long term (not catching the scallops immediately would lead to larger profits in the end) but this didn't happen. The web of relations necessary for the new infrastructure failed.

This story is about a failed attempt to create a new infrastructure that would allow the scientists to 'state a fact' about scallop larvae. It also describes an attempt to reconfigure a hitherto non-existent web of actors – fishers and technologies and knowledge and creatures and tides – into a package in which: there were collectors; larvae attached themselves to those collectors and were not predated or washed off; other scientists accepted this was happening; and fishers supported the experiment because they benefited economically from the increased scallop population. Callon's account illustrates the *heterogeneity* of infrastructural elements that we mentioned above. It shows that properly working infrastructures work *unnoticed* unless they go wrong. It shows that infrastructures are complex *webs of relations* that have to be successfully woven together, simplified and packaged up to create 'reality' (the new 'scientific fact' that scallop larvae anchor). It also shows that going against the grain of dominant infrastructures (the short-term economic pressures acting on fishers) makes building new infrastructures (for conservation) more difficult.

But were the infrastructural conditions of Callon's scientists contingent? Were they *political*, in the sense that they might have been different? It would be easy to argue that all-powerful 'market forces' – the greed of the fishers – caused the conservation failure, and there was nothing the scientists could do about a social structure as big and monolithic as 'capitalism'. This isn't completely wrong (capitalism, or market forces, were obviously at work.) But STS tells us that framing the argument as an example of the power of 'social structure' leaves out a crucial step. It fatalistically excludes the possibility that the fishers *might* have acted differently: that, for instance, the scientists

might have persuaded them to relate differently to the scallops (and thus the economy) if they had gone about their research differently. So, here's the STS lesson: yes, actors operate within powerful contexts. Yes, they are shaped by these. But they also *work on* those contexts, they may (re)shape these, and sometimes they change them. And this opening of possibilities is why *infrastructures* are important. STS suggests that they are more or less durable, but also mutable, because they are woven together in creative practices and depend on the constant reproduction of those practices to be sustained. Vitality, in principle, this means they can be changed. So yes, the infrastructure of 'capitalism' meant short-term profits were central in Saint Brieuc Bay. But things might have been different.

Thinking with 'infrastructures' resists structural determinism. The availability of particular infrastructures shapes what happens and makes some things easier and others more difficult. But it doesn't determine 'reality', because how infrastructures are woven in practice is important too. With this in mind, we turn to a second story about scallops, fishers, and scientists.

The Scallops and the Fishers of Lamlash Bay

The French scientists asked whether *Pectus maximus* scallop larvae would attach to controlled nursery habitats. As we've seen, they failed to find an answer. A similar question was asked by five British scientists thirty years later, about the disappearing scallops of Lamlash Bay, on the Scottish island of Arran. The two cases have much in common. The economic value of scallops, uncertainties around their reproduction, desire for conservation, threat of stock collapse, and scientific uncertainty frame both. But in the Lamlash experiment, the study was based on an attempt to control and increase scallop numbers by creating a 'marine protected area' (MPA). An article in *Marine Biology* describes how this experiment successfully created the scientific fact that there were more juvenile scallops inside than outside the Lamlash MPA (Stewart et al., 2020). But how did the scientists weave existing infrastructures together to achieve this result unlike the scientists described by Callon? How did they reshape 'market forces' so fishers were enrolled into their experimental infrastructure and stayed away?

The answer lies in an awful lot of hard work, spanning many years and involving actors and locations far beyond Arran. Here's the context. Until 1984, scallop dredging within three nautical miles of the UK coastline was illegal. When this law changed, Arran islander and diver Howard Wood watched the growing destruction of the local seabed with horror. In 1989, his friend Don MacNeish returned from a diving trip to New Zealand. MacNeish was enthusiastic about the MPAs he had seen there with their rich and undisturbed seabeds. The two friends decided similar protection was needed in Scotland, and in 1995 the Community of Arran Seabed Trust (COAST) was born. This was the beginning of a two-decade, bottom-up effort to protect Lamlash Bay. Importantly, the initiative was supported by the Arran islanders who had first-hand experience of the decline and collapse of local fisheries since 1984. Also important was the fact that no locals were profiting: the scallop dredgers came from outside. At one point, islanders dropped wrecked cars into the bay to try to destroy the dredging equipment. But this was illegal: in the words of MacNeish "[t]he fishermen had the law on their side and the islanders were powerless to stop them."

Getting the MPA established was, “an uphill fight” that was “dogged by setbacks”, many of which involved the need for islanders to get “the law on their side”. Local support wasn’t enough to protect the seabed, and COAST needed to weave in UK and Scottish environmental *activists* and *politicians*. To do this it needed to mobilise scientists and *scientific evidence* to prove to policymakers that an MPA would increase scallop numbers. Although the destruction of the seabed was apparent to the divers’ eyes, the Lamlash Bay scallops weren’t easily woven into the infrastructure of ‘scientific facts’ either (A 2015 paper said there were more juvenile scallops in the MPA, but this wasn’t true for adult scallops). And, though this wasn’t a priority for COAST, it also needed to weave the politics and the science into *economic arguments* by showing that an MPA would be cost-effective by increasing scallop numbers. Finally, as we also hinted above, it needed to pull sympathetic *legal* experts into the network to persuade the UK to recognise the sea as a public good, so that government would have a duty to recognise the islanders’ right to have a say in its management.

This is a story of success. It describes a new way of knowing brought into being by creating a novel infrastructure. Islanders, divers, fishers, interested outsiders, scallops and the scientific community, all were adapted and woven together to create conservation knowledge. Sub-sea observations (requiring technical diving equipment) were collated and turned into scientific evidence, and academic papers were submitted and published. Maps, legal opinions, economic justifications, policy prospectuses and reports were created and circulated. Such conventional forms of paperwork moved alongside – were a part of – the cultivation of local, Scottish, British, and European political connections. Certain ‘structures’ were present: the UK and Scottish political systems. European conservation directives. Economic lobbies and interests. The legal system. And scientific conventions about proof and publication. But in a slow and difficult process that spanned decades, these infrastructural bits and pieces were drawn on, altered, and woven together to generate a new infrastructural configuration. Lamlash Bay scallops that had been decimated by ‘market forces’ which the locals were powerless to do anything about (remember the cars in the bay?) were protected and started to breed in large numbers again. Infrastructures of conservation were strengthened, while infrastructures of economy were weakened and reshaped.

But why was this so unlike Saint Briec Bay? Since infrastructures are inextricably woven together, there can be no single ‘structural’ explanation. Perhaps the world is more open to ‘ecological’ arguments than it was forty years earlier, thanks to other cases that show the merits, ecological and economic, of MPAs. The Arran effort was a bottom-up project, not one imposed on locals by outsiders, and locals weren’t involved in the fishing. International commitments to conservation leveraged the islanders’ arguments for protection to the Scottish government. It was a slow, organic, and large-scale process that was more expansive and more durable than the scientist-led study in St Briec Bay. With much sustained effort, new ways of knowing, new ways of fishing, and the new infrastructures needed to render these real, were nurtured into being.

But sustained effort is not always enough. With this observation, we move to coloniality.

Part 3. Metaphysics and the Coloniality of Knowing

Economic, technical, scientific and political infrastructures shape ways of knowing, but don't completely determine these. We can end up with an MPA rather than a Saint Brieuc Bay catastrophe. It is possible to create new practices and infrastructures, and new ways of knowing. With skilful understanding and manipulation of the infrastructures at hand (marine biology, conservation policy, international and Scottish law) an outcome was achieved in Arran that went against structurally-understood economic logics.

But some infrastructures are more powerful and entrenched than others. In the next section, we introduce an indigenous struggle in which science and other state-sponsored ways of knowing have squeezed local ways of knowing to the point of extinction and explore what this implies for infrastructures.

Salmon in Deatnu

Called 'Deatnu' by the Sámi indigenous people of northern Fennoscandia, this is a huge river that runs north from subarctic Norway and Finland to the Barents Sea. The river has been a central source of livelihood and communication for Sámi since prehistory. And Sámi people have always fished for salmon (Atlantic salmon, *Salmo salar*) there with Seine nets, drift nets, weirs, and rods from boats. These ways of catching salmon are woven together with place-based and relational knowledge of salmon, of the river and its flow and currents, of the weather, of the time of year and the seasons, and how people and animals and what outsiders might think of as inanimate forces interact, and interact properly, together. They come, too, with practical and observational skills, with a large specialist vocabulary, and a strong ethical sense of what is right and wrong. About, for instance when it is appropriate to fish (fishing for sustenance takes precedence over recreational fishing); about what salmon like (the answer is, peace and quiet); about the importance of respect (salmon choose to give themselves to those who fish them, or not); about fate and the uncertainties of the world (which is filled with powerful morally-sensible entities); and about the need for modesty (you do not count or boast about your catch). This, in short, is a world of traditional (or local) ecological knowledge (TEK). And it has worked sustainably for at least a millennium, and likely a lot longer (Law and Joks, 2017).

But now everything has changed. The British aristocracy came to fish the river for sport 150 years ago, and by the end of the 20th century outsider tourist fishing had become a profitable mass phenomenon. The result? The relationship between the Sámi and the river had to change to adapt to these incomers, who also had implicit state support. And, perhaps unsurprisingly, salmon numbers were falling. Why? This is in dispute. Sámi people point to tourist overfishing, constant activity on the river (salmon need peace), lack of protection when the salmon are preparing to spawn, and the role of protected predators. But fisheries science, backed by state policymakers, draws different conclusions. The fish population modellers agree there is too much fishing but argue Sámi fishing with nets and weirs is particularly damaging. The consequence of this 'fact'? A draconian squeeze on those Sámi practices. Fishing in traditional ways with nets and weirs has been outlawed, and the knowledge and experience embedded in these practices are no longer being

transmitted to young people. Sámi fishing, an important aspect of Sami culture, is being strangled because the infrastructures that sustain its practices and ways of knowing have been made illegal.

Despite sustained protests, the set of infrastructures embedded in fish-stock modelling, in policy, and in the apparatus of the Nordic states has completely displaced the alternative infrastructures embedded in and carried by Sámi fishing practices. And there is little sign that this is about to change.

In the scallop cases we touched on their scientific, technical political, economic, and legal infrastructures. These showed how some ways of knowing are much easier to craft than others because they weave together relatively standard infrastructures in more or less standard ways, while going 'against the grain' of dominant infrastructures can be difficult. But they also showed that in principle it is possible to summon up alternative infrastructures, or weave these together in novel ways, and therefore reshape them. This is what happened in Lamlash Bay. But nothing like this is happening for Sámi ecological knowledge of Deatnu salmon. Science, technology, politics, economics and the law are all working against this way of knowing and the infrastructural practices in which is carried. All these come together to produce, and are in turn strengthened by, their role in the infrastructures of coloniality. And since Scandinavian states have a monopoly over the legal use of force, we need to add discipline and violence to this infrastructural list.

But there is something else going on too. In principle in Norway Sámi local knowledge is legally recognised alongside the fish population modelling of the scientists. It is supposed to feed into policy, because Norway recognises Sámi as an indigenous people with cultural and environmental rights. But in practice this barely happens because Sámi ways of knowing salmon are disqualified on epistemological grounds. They aren't science and they aren't allowed to count because they are considered: experience-based and not model- or hypothesis-derived; intuitive, oral and visual rather than systematic; subjective, not objective; and qualitative rather than quantitative (Joks et al., 2020). As a result, it is a way of knowing that carries little or no weight beyond the Sámi community because isn't methodologically or epistemologically 'scientific' and it doesn't look for universal underlying causal mechanisms to explain what happens in the world. Instead, it assumes that events unfold as an effect of (hopefully respectful) relations between lively and ethically sensible human and non-human beings. Sámi ways of thinking, then, are unacceptable because they aren't colonially realist. They don't *distinguish very strongly between nature and culture*. They don't share the philosophically realist assumption that the natural world is shaped by universal causes.

As we have seen, STS describes the colonial infrastructures of science, technology, politics, policy, economics, and the law. It also, however, shows us that those infrastructures are *epistemological* and *metaphysical* too. And since these different infrastructures also overlap in ways that reinforce one another (only credentialled biologists are authorised to talk about fish-facts to policymakers, for example), reshaping them becomes almost impossible. Bruno Latour (1993) observed that 'modernity' insists on this nature-culture divide, but that it also needs to fudge it; that science is not only messy, but also non-binary in practice. No doubt this is right, but how to think about this realist metaphysical infrastructural division that sustains colonialism and the coloniality of knowing? Is this a 'structure' too foundational and powerful to change? Once again, the STS focus on practice suggests otherwise.

Newfoundland, and an Anti-Colonial Laboratory

Max Liboiron, biologist, STS postcolonial scholar and activist, directs The Civic Laboratory for Environmental Action Research (CLEAR). This is a laboratory in Newfoundland and Labrador, Canada whose members explore marine pollution in ways that respond to and try to respect not only biology but also how indigenous people make sense of and live with the sea and its creatures (Liboiron, 2021). Their projects, findings, and the practices out of which these grow therefore seek to make both biological and indigenous sense. On the one hand, then, if this is to work indigenous communities need to take on a version of biology. On the other, that biology has also been vastly reshaped. How so?

First, it no longer seeks to uncover universal causal laws about nature and pollution. It doesn't trade in strong nature/culture binaries. Instead, lab members' questions attend to contexted relations about food sovereignty, causal and otherwise. Is it safe for this First Nation to eat this fish in this place at this time of year in Newfoundland? This the kind of question that makes sense in CLEAR. Second, it therefore refuses large parts of the colonial epistemic and metaphysical infrastructures included in most marine biology. What happens is no longer a product of universal causal mechanisms that are therefore indifferent to place. Yes, CLEAR members publish scientific papers. But the universalism of colonial realism that we saw in Deatnu disappears along with the division between nature and culture. Instead, its scientists attend to the specificities of relations between morally-sensible human and non-human actors experienced and lived in indigenous communities. Finally, they explore what this might mean in practice.

So, what infrastructures might be taken into, or developed, in such a laboratory? This is a continuing matter of experiment (CLEAR, 2021). However, such infrastructures currently include: creating animal respect guidelines; adopting community peer review; discussing and integrating indigenous understandings of the world; producing open source equipment that can be easily used by people without standard scientific training; problematising usually 'black boxed' methodologies in science like statistical testing; and finding collaborative ways for conducting lab meetings.

The work of CLEAR demonstrates the possibility of alternative ways of knowing. It shows that, difficult though this may be, it is possible to resist the epistemic rigidity and the hard realism that goes with a strong distinction between nature and culture in colonising science. And instead, that it is possible to craft alternative, contextually-sensitive metaphysical, epistemological, and practical infrastructures. And that a good way of doing this is to attend to the practices and values that guide how relations are forged (humility, equity, respect.) A small specialist and STS-inspired marine pollution laboratory thus shows that it is possible to remake the relations embedded in science, and so to challenge the patterns of infrastructural coloniality.

Part 4. Conclusion

STS describes how knowing practices work by including and drawing on heterogeneous material and immaterial infrastructures. Typically taken for granted, these both shape knowing and are (re)crafted in those practices. Knowing differently is hard work – sometimes near enough impossible – because it takes time and effort to remake infrastructures in novel ways. Relative infrastructural

conservatism is easier, even for innovators. But social, economic, academic, legal and material infrastructures can sometimes be remade differently. Even the hard realist epistemic and metaphysical infrastructures of coloniality can be undone. And this is the significance of infrastructures. They are not social structures, and while they shape knowing they do not determine anything. Instead, they are resources. How to draw on and use them is not fixed. Alternative ways of knowing are possible (de Sousa Santos, 2016).

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