How Collaboration with Countries New to Space Activities Transforms the Development of Earth Observation Applications and Research Practices in Japan

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Abstract

This paper examines how collaboration with countries new to space activities transforms the development of Earth observation (EO) applications and research practices in Japan. Rather than reviewing familiar narratives of capacity-building or technology transfer, which cast such cooperation as a one-way transfer to an emerging beneficiary, the study reverses the analytical observation and asks how these partnerships reshape the science of the "giver" itself. It draws on five months of multi-sited ethnographic fieldwork conducted in Japan in 2025 and 2026, combining participant observation with interviews and informal conversations among some twenty researchers and ten doctoral students specialising in EO across half a dozen Japanese universities. Empirically, it focuses on collaborative settings such as the PHL-Microsat programme between the Philippines and Japan (the DIWATA-1 and DIWATA-2 microsatellites) and the BIRDS programme led by the Kyushu Institute of Technology (including the Philippine CubeSat Maya-1). The study shows two results. First, as Japanese national space policy tilts toward commercial competitiveness and security, partnerships with emerging countries function for university EO groups as an alternative infrastructure of funding and organisation: partner nations largely finance the satellites, decision cycles are shorter, and researchers gain room to experiment that domestic programmes no longer readily afford. Second, these partnerships operate as a site of two-way knowledge co-production. Needs articulated by partners, particularly around agriculture and environmental monitoring, reshape how Japanese researchers design missions, validate data against fieldwork and local knowledge. International cooperation does not leave the established partner's science intact but transforms it in return, displacing the conventional framing that opposes donor to recipient and centre to periphery.

1. Introduction

On 27 April 2016, a fifty-kilogram microsatellite was released from the Japanese Kibo module of the International Space Station and began to orbit over Southeast Asia. DIWATA-1 was the first Philippine satellite[1], celebrated in Manila as a source of national pride and as the country's entry into the club of space nations. This Earth observation satellite had been designed and assembled not in the Philippines but in two Japanese universities, by a handful of Filipino engineers who had come to train there. Some Japanese told me, with pride, that the success of this satellite, as well as that of Diwata-2 and Maya-1, counted for much in the creation of the Philippine Space Agency in 2019.

DIWATA-1 is one example among others. Cooperation and collaboration between established space powers, helping a newcomer to design, launch and operate a first instrument, is no longer a rarity. The usual emphasis falls on the benefits of technology transfer, on space as a tool of diplomacy, on the narrowing of the gap between North and South, and so on. But what happens if we turn the camera around, and, rather than asking what space authorities such as Japan bring to their partners, we turn to the influence of these partnerships on the Japanese space sector, and here, on the EO laboratories and research in particular?

EO is, without doubt, one of the the field where this cooperation carries the heaviest social consequences. Earth observation data feed a vast range of applications, from crop monitoring and water management to the response to floods, earthquakes and tsunamis, by way of the tracking of deforestation and biodiversity, and they are put to explicit use in the service of the 2030 Agenda and the Sustainable Development Goals[2] [1]. This social value has nothing automatic about it, it pivots on the fit between instruments, data and concrete, situated needs, which makes cooperation with the countries where those needs arise all the more decisive.

To address this question, the article brings together two frameworks. The first is the literature on space cooperation, in particular between countries of the North and of the South. This literature looks, on one side, at strategic motivations, regional influence or cost sharing and, on the other, at what emerging partners draw from it in terms of capacity building and of a path toward space autonomy; these small satellite arrangements remain, as a policy instrument, under-theorised and described above all from the practice of those who carry them out [2]. A more critical vein points out, in the end, that such arrangements can reproduce the asymmetries they claim to reduce [3]. Yet in these perspectives, the arrow of transfer runs from North to

[1] ABS-3 (Agila 2) was the first Filipino-owned satellite to be launched into space, but not the first Filipino satellite.

[2] Committee on Earth Observation Satellites (CEOS) (2018). Satellite Earth Observation in Support of the Sustainable Development Goals. ESA/CEOS.

South, and the science of the established power is treated as a stable given, one that spreads and shares without being changed. This is the blind spot we propose to explore.

The second framework is anthropological. We place this work within the anthropology of science, which studies through ethnography the ordinary gestures and practices of knowledge making, and which has shown for a long time that the ways of "doing science" vary from one collective and one place to another [4], as well as within the anthropology of space [5, 6, 7, 8]. The concept that binds these strands is that of co-production, whereby the order of knowledge and the social and institutional order shape each other, without one preceding or determining the other [9].

The Japanese space sector is going through a fast reconfiguration, ordered by two national priorities. The first is commercial competitiveness, backed by a funding effort of unprecedented scale and by the stated goal of doubling the size of the national space market. The second is security, in a context of rising defence budgets and of a growing dual use of space. Science, which had been the banner of Japanese space since its beginnings, becomes secondary, and remains present. Funding is harder to obtain, competition grows. University researchers in Earth observation use cooperation with countries new to space as an alternative means of funding their research and of sending satellites or instruments into space. What influence does this cooperation have on the development of EO applications and research practices in Japan?

2. Material and methods

This article is part of a larger research project, carried out within a postdoctoral position in anthropology at the Chaire Espace of the École normale supérieure-PSL, and devoted to the conceptions and practices of "space sustainability" in Japan. The fieldwork was funded by the Chaire. The general aim of this fieldwork was to exchange with the largest number and the widest variety of actors in the Japanese space sector: researchers, industry people, JAXA staff and start-ups. The article draws on the Japanese scientists who specialise in Earth observation.

This article rests on two stays in Japan, five months in all. The first, from June to August 2025 (two months), covered the south of the archipelago, in particular Okayama, Kitakyushu, Tottori and Oita, with an almost weekly move. The second, from December 2025 to February 2026 (three months), was in Sapporo alone, giving priority this time to the long haul, so as to talk with and observe the various interlocutors. This sequence of fieldwork belongs to a multi-sited approach, where one follows a single object, here cooperation in Earth observation, across several places and at several scales.

I spoke with some twenty researchers and about ten doctoral students and students who specialise in Earth observation, attached to half a dozen Japanese universities, among them the universities of Okayama and Hokkaido. Contact was made on site, and, as things went along, I had the luck of being recommended to other people. The exchanges took place in English for the most part, in Japanese at times. My level of Japanese is enough for simple conversations; the more technical discussions were held in a mix of the two languages. The quotations reported here are translated into English by the author, so as to ease reading, and reconstructed from notes.

The material was produced by three complementary means. The first is direct observation with note taking. During stays of several days in some universities, I was able to observe the work of the teams and to benefit from guided tours of the laboratories. The second is the semi-structured interview, not recorded. The third, and the most frequent, is the informal conversation, which, less subject to the staging of the self than the formal interview, takes place in the very course of the activity, at the workstation, during a visit or around a meal, and gives access to words that are more spontaneous and often blunter.

The interlocutors were informed that I was conducting a field study of the Japanese space sector. The data are anonymised, no name is cited, and people are designated by their role and their speciality. The small size of the Japanese Earth observation community makes this precaution a delicate one, since the combination of a role, a precise institution and an identifiable project could be enough to re-identify a person. I therefore name some institutions as context, but I keep this information apart, as far as I can, in the way the words are presented.

The hypothesis is that these partnerships play, for Japanese researchers, a double and inseparable role. They form, first, an alternative infrastructure of funding and organisation, which lets them go on designing, flying and operating a science that the national apparatus no longer supports as a first priority. But they also form a site of co-production, where the needs voiced by the partners, around agriculture and environmental monitoring, come to reshape the Japanese ways of designing missions, of validating data and, at a deeper level, of defining what Earth observation can and must do. Far from leaving the science of the established power intact, the cooperation transforms it in return. We hold, moreover, that this movement plays out less in the discourse of the programme heads, where the question of funding dominates, than in the daily work of the field researchers and of the doctoral students who come from the partner countries, true carriers between the needs of their country and the engineering of the Japanese laboratory.

3. Theory

Earth observation is not a neutral technical gaze, it is a political object and a social construction. The history of the Landsat system was the subject of a classic study of social construction [10], and a critical tradition has analysed Earth observation as a political technology in its own right, alert to the way the satellite gaze connects to relations of power and to the sovereignty of states over the information concerning their own territory [11]. This programme carried on in the work linking remote sensing and the social sciences, which studies the relations of power inscribed in the production and circulation of satellite images [12]. Far from being a universal and homogeneous technique, Earth observation is shaped by national sociotechnical imaginaries, the state and the scientists of a given country defining the scope, the methods and the uses they assign to it [13]. The literature sheds light on the power of the image; it dwells little on cooperation in EO.

This space cooperation between countries is, as we saw in the introduction, analysed for the most part from the side of the emerging partner. The dominant frameworks think of it as a climb, the partner ascending a "space technology ladder" from the first turnkey instrument to a capacity for autonomous design, and as the closing of a "space divide" that cooperation with the established nations would fill. The critics themselves, who seek to move past this view, stay turned toward the receiver and give little attention to how the scientific practice of the power that "guides" changes on contact with the one that "receives".

This shift means giving full weight to the local making of science. Anthropology and STS have shown that the ways of "doing science" are not universal. The ethnographic comparisons of a Japanese physics laboratory and of a United States or French laboratory revealed norms of work, career paths and relations to the collective that stand in sharp contrast [4, 15]. This field has described, through ethnography, the way teams, robots and images make the knowledge of other worlds [15], the cosmologies and the futures promised by "NewSpace" [16], and it gives sustained attention to infrastructures and to what has been called the "half-life of empire" in space, where colonial history carries on [5]. A recent critical turn insists, for that matter, on coloniality, the "new space race" extending and reshaping terrestrial geopolitical hierarchies, which joins our first body of literature. But its favoured fields have been those of planetary scientists, of the teams of the large agencies, of NewSpace and of the Space Station, in the North for the most part; cooperation in Earth observation between an established Asian power and emerging partners remains, in large part, a blind spot.

To study co-production from the side of the giver makes it possible to hold together what these traditions have treated in isolation: the asymmetry between North and South, the situated

specificity of scientific practices and the earthly character of space. It is from this base that we examine not what cooperation builds in the South, but what it recomposes in the North, following the daily practices by which the needs of the partners enter Japanese science, and that we lay the ground for a longer study, one meant to measure the scale and the durability of this movement of return.

4. Results

Two major conclusions emerge from this research. They are closely related but analytically distinct. First, within the context of a national funding system that is both more restrictive and reoriented, partnerships with emerging countries function as an alternative funding and organizational infrastructure, enabling Japanese laboratories to continue designing, launching, and operating Earth observation missions more "easily" than through traditional channels. Second, these partnerships also serve as a forum for the co-production of knowledge. The needs expressed by partners reshape design and validation practices, and even the very objective of Earth observation research. These effects are more visible among field researchers and doctoral students than in the discourse of principal investigators (PIs).

A third element, discussed here with more caution, is that certain actors in the Japanese space sector highlight a "cultural" methodological difference while working on EO.

4.1 "Money is everywhere": funding as a condition of possibility

Across five months of fieldwork, "money" was one of the themes that surfaced most often in the words, the worries and the hopes of the people working on space, whether in research, in industry or in the commercial sector. Whether the question was to build a launcher or a satellite at the lowest possible cost, to apply for scholarships or funding in the hope of one day sending an instrument aboard the International Space Station (ISS), or to view space as a new way to prosper, money is everywhere. In the laboratories and among the Japanese researchers who specialise in Earth Observation, the population at the centre of this study, money appears as a condition of possibility for science itself.

That condition has hardened. A professor of cosmoscience specialising in microsatellites describes the transformation of the universities' core funding:

"The annual state grant to national universities (運営費交付金, un'ei-hi kōfukin) has become a competition. Before, there were no conditions, and that allowed for more creativity in the way we did science. Today, and since the early 2000s, you have to meet a certain number

of criteria, such as international visibility and a certain number of publications in English. Funding is very hard to obtain".

This hardening is compounded by a reorientation. Within the national space agency itself, Earth Observation is no longer a priority, and access to its missions is conditional on bringing one's own resources. A professor of astrophysics who has flown hardware from the Japanese Kibo module puts it plainly:

"With JAXA, if you show up with money, it is relatively easy to attach yourself to a mission. Slow, very slow, but not too hard. If you have no funding, on the other hand, it is almost impossible. There is so much competition, and it is much harder today, especially since EO is not the priority".

The picture that takes shape, from the researchers' point of view, is that of a national funding landscape that is at once more competitive, more "criteria driven" and less favourable to civil academic EO.

4.2 *Partnerships as an alternative funding infrastructure*

When asked about their relations with emerging countries, the PIs do not put knowledge sharing first. They put funding first. As a professor of planetary science phrases it, these countries pay a great deal of money, "especially relative to their GDP", to the Japanese university, in order to send up their own satellite and to learn to operate it. At this level, the relationship appears first of all as a flow of resources.

The magnitudes observed support this framing, although the arrangements vary from one case to another. The Philippine government's contribution to the PHL-Microsat program, which produced two 50 kilogram microsatellites, DIWATA-1 and DIWATA-2, was on the order of ¥800 million (about $7 million). The joint program with Myanmar is a clearer case still: two 50 kilogram satellites funded in full by the Myanmar government, for approximately ¥1.7 billion (about $15.3 million). In the Vietnamese case, the funding passed through a Japanese official development assistance (ODA) loan. For a university group, resources of this kind do not depend on winning competitive national funding. They constitute a way around the bottleneck described above.

To this financial dimension is added a dimension of organisation and speed, also mentioned frequently. The time between the start of the cooperation and the launch of the satellite or the instrument is regularly contrasted with the slowness of JAXA, described more than once as "very slow" and "too rigid". According to the interviewees, the partnerships offer shorter decision cycles, and a room for experimentation that the large national calls do not allow.

4.3 *Designing missions from "real needs"*

If funding is what brings the partners in, the way the missions are designed orients the research, from the outset, towards applications that are those of the partners. Several university centres explicitly claim an inversion of the classic model.

The Space Mission Center (SMC) of Hokkaido University is one example, and its model recurs, in various forms, across other Japanese university centres. Its heads describe an approach that seeks to invert the "top to down" model, in which the launcher and then the satellite are decided first, and the instruments and the uses only afterwards. The SMC claims, on the contrary, an interdisciplinary design that brings together field scientists (in ecology, agriculture, geosciences) and space engineers, so as to define "relevant" missions on the basis of "real needs". The stated purpose, "space for public good", subordinates the platform to its use, at least in the discourse.

The Philippine microsatellites DIWATA-1 (deployed from the ISS in 2016) and DIWATA-2 (launched in 2018), developed with Tohoku University and Hokkaido University, carry optical payloads whose purpose is explicitly applied. The applications actually carried out all bear on problems located in the partner's context: mapping the turbidity of the largest lake in the Philippines, tracking ashfall coverage after a volcanic eruption, and monitoring typhoons. The success of this cooperation is, moreover, linked with pride by the actors to the creation of the Philippine Space Agency.

The BIRDS program, run by Kyutech for "non space faring nations", shifts the logic towards the educational nanosatellite. The missions carried on Maya-1, a store and forward system that collects and relays data from ground sensors, an amateur radio relay usable for emergency messaging, and cameras, answer needs articulated by the partners (connectivity in isolated areas, disaster management) rather than a predefined Japanese scientific agenda. Here too, the definition of the mission proceeds from the partner's problems.

In both programs, designing "from needs" means that the agricultural, environmental and risk related concerns carried by the partner countries enter, from the earliest stage, into the definition of the instruments and the uses.

4.4 Co-production of knowledge in the field

If, at the level of the PIs, the partnership presents itself first as a funding device, it is at the level of field scientists and doctoral students that the co-production of knowledge becomes most tangible.

A researcher who specialises in agricultural monitoring and in the development of agrometeorological information systems describes a use of satellite imagery that is qualified from the outset. Working from free imagery (Sentinel-2), he stresses its limits in the field:

"A single mass of cloud can be five kilometres across. We need not only the 'traditional' knowledge of local people, but also to entrust them with tasks such as taking measurements or photographs for us. Satellites are far from sufficient".

The satellite datum is thus subordinated to field measurement and to local knowledge, held to be "indispensable". More than that, it is this collaboration with actors on the ground that allows the researchers to produce data that is usable and complementary to the use of satellites.

The configuration observed among certain researchers, and in particular a person who works on carbon accounting in a tropical setting, shows that it is not only the validation of knowledge production that is hybrid, but its whole structure. Their models rest very largely on satellite remote sensing. Without satellites, the most demanding levels of carbon accounting (Tier 3) would be out of reach. Yet it is an in situ data collection system, located in the partner country, that validates this data and calibrates the models. The reliability of the satellite product thus depends on a field infrastructure, and the whole is structured by an environmental problem situated in the emerging country with which Japan cooperates for the launch of the satellites.

These reconfigurations pass, above all, through people. In the programmes I observed, a satellite is designed, integrated, tested and operated by master's and doctoral students recruited from the partner countries, who spend between one and three years in the Japanese laboratory. Their days unfold in a small, multinational world: a shared workspace and often a shared dormitory, meals cooked for one another, participation in local festivals, and a know-how handed down in person from one cohort to the next through deliberately overlapping project generations. It is here that a partner country's "needs" acquire a concrete author, for it is the students who select the missions their satellite will carry, and they select them from the problems of home. Across the cases I followed, the same national concerns recur: relaying data from ground sensors scattered where no network reaches, keeping a channel open when a disaster severs ordinary communications, or simply imaging one's own territory and its neighbours, as with Sri Lanka's Raavana-1. The satellite becomes a technical formulation of a situated concern, down to the national motif that several teams inscribe on its outer face.

The traffic, moreover, runs both ways. The Japanese students and researchers who work alongside these teams are not only instructors, several told me that they had picked up, from their foreign colleagues, ways of posing a problem or of improvising with materials that they would not have reached on their own. And the tie outlasts the launch. In one case I followed,

former students returned home and founded, in their own country (Mongolia), a space company that now collaborates with the very laboratory that trained them, so that the laboratory finds itself, years later, cooperating with an interlocutor of its own making.

4.5 *The revendication of methodological differences*

A final element can be raised here, though with caution. A share of the interviewees, in particular around environmental models, spontaneously voice the idea of a "cultural" difference in method. According to them, the physical data would be shared, but the interpretation and the causal narratives would differ, a "Western" tradition, more reductionist and more prudent, standing against a more "systemic" and relational way of thinking that they associate with Japan and East Asia. This representation, held by the Japanese interviewees and common enough to be cited, must be discussed with care. On one side, it risks essentialising "ways of doing" that, in the field, appear shifting rather than homogeneous. On the other, it coexists with devices (publication in English, international standards) that standardise practices. The Japanese researchers mobilise "culture" in their own technical discourse, even when I do not mention that I am a cultural anthropologist, and they themselves draw a distinction between their way of "doing science" and that of Westerners.

5. Discussion

The reach of these results lies first in a reversal of the way space cooperation is approached. In the introduction, we saw that most of the research on the subject takes the question in a single direction, with the science of an established power treated as a stable given that spreads and shares, with no mention of its own transformations on contact with these forms of cooperation. Our results place their focus on this last point. Let us add that small satellite cooperation between an established power and emerging partners remains little theorised, described above all from the practice of those who carry it out, or from what it brings to the space sector of the emerging countries [1, 2].

The different levels at which these forms of cooperation are read, seen by the actors of the Japanese space sector as a funding device and as a co-production of field-based knowledge, are not a contradiction. They operate at different scales. The funding regimes, for the most part institutional, are the infrastructure of scientific cooperation, one that lets the two orders shape one another without one coming before the other [18]. Even in the discourse of the PIs, which turns on the difficulty of finding money or on the competition for funding, a discourse that is,

all in all, ordinary in the scientific world, they deserve to be heard, for behind this question of money there are tensions, there are people, and there are ways of "doing" space.

When the needs voiced by the emerging countries, around agriculture or environmental monitoring, are translated into the choice of instruments or protocols, there is a technical shaping of the social [19]. These shaping runs, in particular, through the master's and doctoral students who come from the partner countries and work for one to three years in the Japanese laboratories, students whom I had the luck to observe and to talk with, and whose daily life gives a picture of this exchange. The students learn not only to build a satellite, but also the language and the work culture of the Japanese labs, such as monozukuri, mottainai, or the 5S method. A Vietnamese doctoral student explained, with pride, that even though the students define the mission, design and test their satellite, they "exude" Japanese know-how.

On the other side, the students do not only invest the co-production by choosing the onboard systems and the design of "their" satellite; they also bring to the Japanese laboratories and researchers a creativity and new ways of thinking. Although engineering is a common language, many Japanese researchers reported that they "talk about the same thing, but not in the same way". For satellites such as Raavana-1, many Japanese researchers spoke to me of their foreign students' choices as to the materials and the composition of the satellite, either taking cheaper materials not meant for space (glue, tape, and so on), or turning the use of these materials to other ends. These different ways of working come to feed the way Japanese researchers conceive and think their own mission.

These results must be placed back in a context, that of a Japanese space sector recomposing itself around two priorities. The first is commercial: launched in 2024, the Space Strategy Fund (宇宙戦略基金) endows space R&D with about one trillion yen (close to seven billion dollars) over ten years, managed by JAXA for the benefit of firms and universities, with the stated goal of doubling the size of the national space market by the start of the 2030s. The second is one of security and defence, extending an old trajectory that took the Japanese space sector from the market toward the military [20]. Earth observation, and science in general, is, of course, present in the national priorities, if a little more in the background. Space is no longer, for Japan, a place given over to "peace and science" alone, and, as many researchers across all disciplines have stressed, the competition to "do science" and to work on space is harsher and harsher.

This recomposition touches not only budgets and organisation, but also what one might call the sociotechnical imaginary of Earth observation among the Japanese, that is, the collective representation of what these techniques are for, of their reach and of their legitimate uses. Far from being a neutral and universal gaze, EO is shaped by such national imaginaries, as the

analysis of the Chinese case has shown, where the state and the scientists redirect the technique from observation toward the prediction and the governance of society [13]. The Japanese imaginary undergoes a shift of its own, with the scientific and peaceful banner of Japanese space growing plural, one in which commercial competitiveness and security hold a growing place. In working on Philippine rice, Vietnamese floods or the peatlands of Southeast Asia, Japanese researchers come to conceive of EO less as an instrument of observation and of national prestige than as a service rendered to situated needs, ones that lie beyond the Japanese borders. Where the Chinese imaginary turns the satellite gaze inward, toward the population and its government, the one taking shape in these laboratories turns in part outward, toward the concrete problems of the countries with which they cooperate. Cooperation with the South is not the only force reshaping this imaginary, but it is one of them, and one of the most discreet, for it acts not by decree but through the slow impregnation of scientific daily practices.

EO by way of small satellites enjoys a relative autonomy and lets researchers "fly and go on working in space; even if it is not under a Japanese flag, the design itself is Japanese". The "space for public good" displayed by the university centres is a survival strategy for a form of science that has lost its rank and, in part, an instrument of regional influence; the pride, voiced time and again, that the result is "one hundred percent Japanese" recalls that the national dimension is never far off.

In listening to the Japanese scientists and the foreign students talk and debate about these space partnerships, the use of the terms "culture" or "cultural difference" came up, of their own accord, again and again. This difference between a Western culture and an "Asian" one, with the sense that it is "easier" to work between Japanese and Vietnamese than between Japanese and American, is present as well. Yet one must take care not to jump to the conclusion of a Japanese or Asian "scientific culture" set as a block against a Western one. Culture here is something that the actors keep mobilising and reassembling in their technical discourse, rather than an essence that would explain their practice: it belongs to what has been described, in the case of Japanese robotics, as a "repeated assembly" of science, technology and culture, called upon by the practitioners themselves even as they take part in the global development of their discipline [21]. Academic and scientific cultures are not closed and homogeneous structures; they travel and recompose over the course of projects, as we can see in the making of these microsatellites.

This heterogeneity of "ways of thinking" is all the more visible in that it unfolds, according to the interlocutors, in a milieu that pushes toward uniformity: the standardisation of satellite models, publication in English, the international assessment indicators that were put in place,

for the most part, by the countries that dominate space at present, the countries of the North. The methodological diversity valued in these forms of cooperation is not, then, the opposite of standardisation; it meets its limits, for that matter, in the constraints of the industrial and security ecosystem in which this science finds itself. A Filipino researcher, who had done his studies in Japan, recounted that it was much harder to build a satellite in the Philippines, not for a lack of know-how, but because the materials had to be imported, the Filipino factories not yet having taken up the satellite bus.

A few limits should be stressed before concluding. The first has to do with asymmetry. To claim that knowledge circulates in both directions does not amount to saying that the relationship is equal. The benefit most looked for in an international collaboration, the transfer of knowledge that passes through shared work, does not come about in the same manner when the partners are unequal [22]. Space cooperation as an object shows that such cooperation gives rise to a certain dependence, and even if the Japanese researchers help the students as best they can to replicate what they have learned once back in their country, that country may lack infrastructure, access to launch, test facilities or supply chains for components. Above all, the works that describe these forms of cooperation do so, in almost every case, from the point of view of what the receiver gains, by counting the number of people trained [2], and the very vocabulary of the "space divide" casts the relationship in a single direction, from the "provided for" toward the "deprived". The reversal put forward here does not hold the thesis of a relationship balanced through and through, but seeks to observe this international cooperation through the ties and the co-production established by the two countries.

The field's own frameworks confirm this split. Analyses of satellite programs in developing countries chart an idealized "space technology ladder", a rising path from the founding of a national agency to the ownership of a satellite and, at its summit, the capacity to launch [17]. A closer study of six such programs adds precision: the emerging organizations gain autonomy in defining their missions and operating their satellites, yet stay dependent on foreign partners for design, manufacture, testing and launch [2]. This division, autonomy and dependence matches what I saw in the laboratory, where students set the mission of "their" satellite while the satellite took shape in Japan. My observation of a single site meets a finding drawn from many countries. But this literature reads the architecture in a single direction, as capability accruing to the South. Seen from the laboratory, the same architecture carries a second effect: the arrangement that trains the partner, students who define and build their own satellite inside the host laboratory, is the conduit through which the partner's problems enter and reshape the science of the host.

The second limit is one of method. As noted above, this work rests on some twenty researchers spread across half a dozen laboratories, which remains a small population. Multi-sited fieldwork, which follows a single object across several places, trades in principle a share of depth for the capacity to grasp a shared dynamic [23] ; yet our design sought to ward off this risk by combining the multi-sited breadth of the first stay, in the south of the archipelago, with a tighter immersion phase of three months in a single centre, in Sapporo, where the long haul made possible the close observation that the first part did not allow. We take care, all the same, not to generalise these results to the whole of Japanese laboratories.

The third reservation has to do with the foregrounding of "Japanese culture" by the actors themselves, through the essentialising of a recurrent lexicon such as monozukuri or "the Japanese spirit". Mottainai, the ethic of no waste, is held up as a distinctive trait of Japanese work, at the very moment when the development of a satellite, with its prototypes, its test campaigns and its single-use materials, in fact yields a sizeable amount of scrap. To take these words for explanations would be to confuse the representation that the actors give of themselves with the working logics of their practice. The role of the analysis is to hold these cultural statements as data, to be questioned as such, and not as the key to the phenomenon. The question is not whether Japanese science is "really" more sparing or more systemic, but to understand why its practitioners feel the need to put it this way, and what this manner of telling their own story does to the cooperation.

5. Conclusions

To the familiar tale of a space power helping a newcomer join the club of space nations, this article has set another question. What do these forms of cooperation do to the science of the one who helps? In following Japanese Earth observation researchers and their partners from countries just arrived into space activities, we have shown that these partnerships play, in Japan, a double role. They form, first, an alternative infrastructure of funding and organisation, one that keeps alive a civil, academic and cooperative science that the commercial and security reorientation of the national space sector no longer supports as a first priority. They form, next, a site of co-production, where the needs of the partners, around agriculture and the environment, reshape the Japanese way of designing missions, of validating data and of defining what Earth observation can and must do. This movement reads less in the discourse of the programme heads than in the daily work of the field researchers and the doctoral students, who learn a Japanese way of doing while bringing into it the problems of their own country.

Cooperation does not, then, leave the science of the established power intact, it transforms it in return. This finding shifts the usual scheme of one-way transfer, from North to South, without any claim that the relationship has become equal, for the asymmetry remains. To measure the scale and the duration of this reverse current is the task that this exploratory research opens and that a longer immersion will carry on. For if we want to understand what space does to the nations that enter it, we must also look at what it does to those who accompany them there.

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