Revitalization of Japan's Forests with ICT: Challenge of Satoyama Capitalism and Promise of IoT in Maniwa

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1. Introduction: State of Japan's Ailing Forestry Industry

Japan's forests cover some 70% of the land, making it one of the most heavily forested and richly endowed countries in the world. Moreover, the quantity of timber in its forests—the so-called *forest stock volume*—is increasing. Yet rural communities in the mountainous areas of Japan face a common set of problems as people migrate to the cities: rural communities become sparsely populated, increasingly elderly, and some communities are in danger of disappearing altogether. These villages and towns all across the country must figure out how to exploit their forest resources, how to diversify and expand the timber industry and other businesses, how to create jobs, and how to grow their local populations.

But developing forestry, the lumber industry, and other businesses that exploit forest resources is not easy. The general consensus among people close to the industry is that "there is no money in forestry." In the wake of World War II, forestry fueled the post-war building boom and was the star of the rural economy, but that all started to change about 1975 when the industry started to decline. Gross output from timber production fell from ¥967.4 billion in 1980 to ¥221.1 billion in 2013. Meanwhile, the number of forestry workers has also fallen off precipitously with only about 80,000 people working in forestry-related jobs today (roughly 0.1% of Japan's total workforce).

There are a number of reasons for this steep decline of the timber and other forest resource industries. Perhaps the biggest reason is that Japan liberalized its timber imports which opened the floodgates to cheaper lumber from aboard, and this coupled with the soaring cost of labor in Japan meant that domestic timber could no longer compete. At the same time, aesthetic and lifestyle changes in Japan reduced the demand for lumber products.

If the forestry and timber industries are truly on the skids, then one might question whether the introduction of ICT could have any impact that might turn this situation around. Yet there are 1000s of local communities scattered across Japan—the town of Maniwa in Okayama Prefecture among them—that are surrounded by majestic forests covering 70% of the country, and these towns must come up with a way to survive and flourish in their woodland surroundings. Now Maniwa and some other communities have embarked on the long road toward regional revitalization by leveraging the power of ICT to make the most of their local resources. Perhaps no one is going to get rich dealing in forest products, but we are starting to see a reawakening of a community where young people in their 20s and 30s and women can make a decent living from forestry.

2. Satoyama Capitalism: Maniwa Leverages Forest Resources Through Industry-Government Partnership

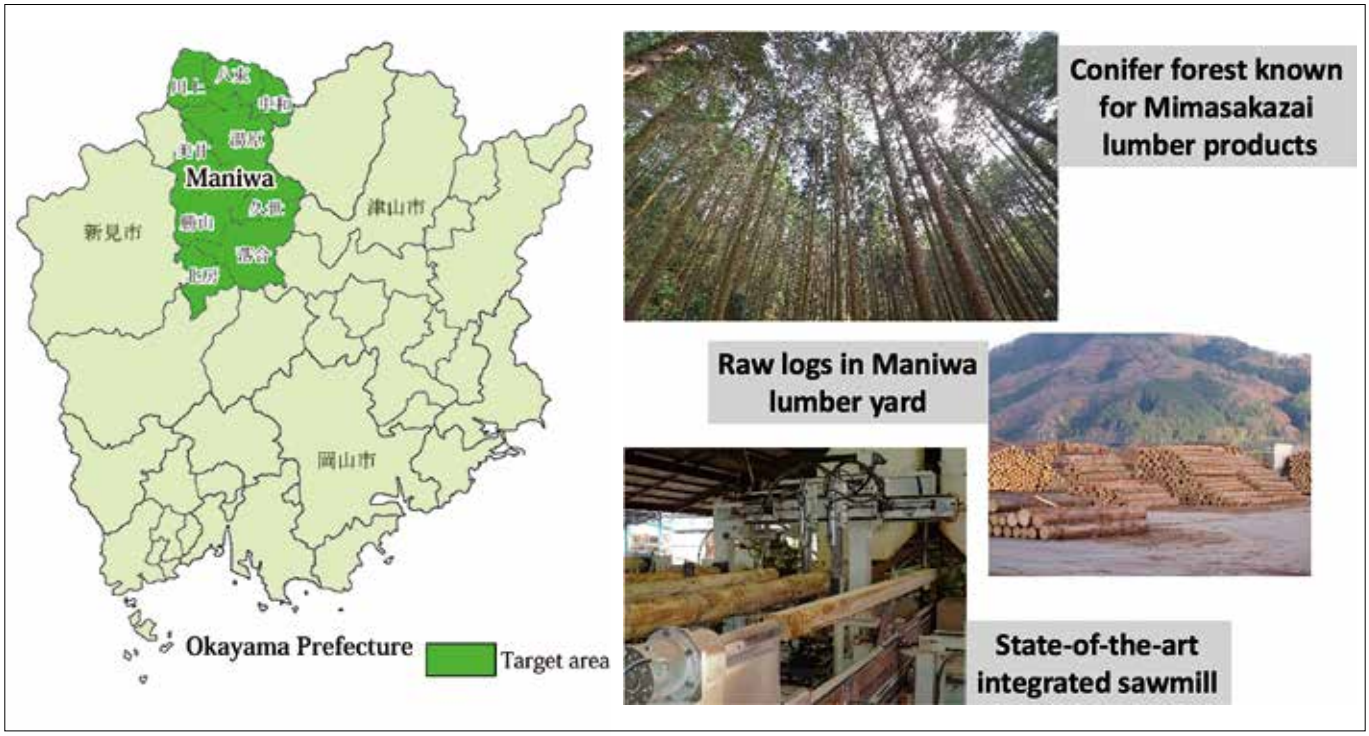
The modern city of Maniwa is in the northern part of Okayama Prefecture on the border with Tottori Prefecture, and was established in March 2005 through a merger of five towns and four villages all from the Maniwa district. After the merger, the population of Maniwa was about 50,000, but the population continued to decline as the elderly population increased and the birthrate declined. Over the five year period from 2005 to 2010, the population fell by about 10% for a loss of another 5,000 people. To come up with some sort of plan to deal with this harsh reality, leaders from throughout the community including some of the older officials from pre-merger Maniwa as well as younger management people joined forces and began searching for a solution. One proposal that came up repeatedly was the idea of bringing back and reviving the timber industry and other forestry-related businesses that had been the community's primary bread and butter in the past.

Roughly 80% of the land area within Maniwa's city limits is woodlands, and timber and lumber have been the key industries of the region. The area was extensively afforested in the middle Meiji years (late 19th century), and Maniwa's lumber industry evolved very quickly as a timber supply base for the Keihanshin region—the area including Kyoto, Osaka and Kobe—with the opening of the railroad in 1936. Today, Maniwa is still regarded as a leading center of forest products with 30 lumber companies concentrated in the area.

But Maniwa is not just about timber and building materials. Universities and research labs collaborate in R&D of nanotech materials and in harnessing electrical power and heat supplies as sources of energy, progress has been made in exploiting so-called woody biomass, and industry-academic-government interests have joined forces in a quest to break away from the old industrial structure of the past. Some of these more recent developments have been taken up and discussed in detail by Kosuke Motani in his best-selling book "Satoyama Capitalism" (Kosuke Motani and NHK Hiroshima, Kadokawa Shoten).

How ICT might be applied to Maniwa's forest industry also came up in joint industry-academia-government discussions. When timber is used as building materials, biomass, and various other ways, the next obvious question is how one harvests the timber that has all these practical uses. And in order to harvest a stable supply of lumber, one must have a fairly precise grasp of the amount of timber that is available in the area. Finally, when it

Figure 1: Mountainous Maniwa: location and scenes around town



comes to the actual logging, one has to know who owns the land, for the land owners and loggers have to work out how many board feet will be cut, allocation of costs and revenues, and a host of other factors. This requires detailed data revealing the distribution of forest resources and maps showing the land ownership status. Unfortunately, this information is not nearly as accurate as it should be, it is a huge headache to match up and collate paper maps showing the distribution of timber resources, and many if not most of the local people are not comfortable using this kind of data.

Basically, Maniwa needed was a scheme for collecting, digitizing, and storing data that clearly indicates how many trees are on what parcels of land, who owns the parcels, and then make that data readily available to all the stakeholders in the community. Some doubted that we could implement such a scheme, but we made good progress, and the project really started to come together around 2011.

We applied for funding as a Ministry of Internal Affairs and Communications (MIC) supplementary budget 2012 *ICT Smart City Project*, and our proposal to implement a demonstration scheme was accepted. The demonstration trial was completed in 2013, and now virtually everyone involved—government officials, forestry people, especially forestry cooperative staff—thinks the system is absolutely indispensible, and it would be impossible to do our work without it.

3. Deploy Forest Cloud and Drone (UAV) to Map Local Terrain

Working together with a major ICT-related corporation in Okayama Prefecture (Okayama Cyuou Sougou Jyouhou kousya: Okayama Central General Information Public Corporation), we developed two basic MIC *ICT Smart City Projects* proposals: First was the *Forest and Forestry Cloud* jointly used and managed by the Maniwa City Office and the Maniwa Forestry Cooperative, and second was a *Drone (UAV)* that uses remote sensing technology to efficiently survey and map current forestland terrain.

(1) Forest and Forestry Cloud to Visualize Local Forests

The Forest and Forestry Cloud uses geospatial information technology to superimpose forestland ownership data (owner's name associated with each section; also known as *current parcel number plots*) and other current updated data onto aerial photographs, then display the images. Essentially, it is a type of geographic information system (GIS). Note that the parcel numbers allocated to owners are also used as ID numbers for managing forestlands, so one can quickly ascertain the owner of a parcel from the ID number. And since the Maniwa Forestry Cooperative periodically updates past and present logging activity records, one can get a fairly accurate picture of the current state of forestlands. Now the availability of the Forest and Forestry Cloud make certain tasks much easier and efficient: one can immediately grasp who owns what parcel of land by simply glancing at the screen (a task that used to take several days), and landowners can quickly generate the drawings needed to accompany subsidy applications by simply printing out a screenshot of the contents (a procedure that used to take at least a day).

(2) Robotic Drone to Grasp Forestlands in Real Time

The Forest and Forestry Cloud is equipped with digital aerial photos of the whole area plus charts derived from the aerial photos showing the distribution of different tree species. Aerial photos provide excellent data for tracking the current state of forestlands or explaining current circumstances to owners or other stakeholders, but the photos can get out of date as trees mature, are

Figure 2: Forest and Forestry Cloud (forestry management information system): primary uses and division of roles by Maniwa City Office & Maniwa Forestry Cooperative

Maniwa City Hall functions

- ✔ Capabilities to make forest conservation operations more advanced and efficient including custody over forest roads, profit-sharing forests, applications for forest reserves, parcel number status maps, etc.
- ✔ Disaster-prevention measures such as custody of the antiflood control afforestation ledger, the erosion control ledger, etc.

Maniwa Forestry Cooperative functions

- ✔ Capabilities to make forest operations more advanced and efficient including custody of local forest operation history, management of logging roads, etc.
- ✔ Investigate forest management strategies that improve efficiency of using digital aerial photos and sensing data taken from by drones, etc.

Source: Okayama Cyuou Sougou Jyouhoukousya (Okayama Central Information Public Corporation)

Photo: Drone deployed for forestry management

Source: Okayama Cyuou Sougou Jyouhoukousya (Okayama Central Information Public Corporation)

logged off, or when the landscape is altered by natural disasters.

Maniwa thus conducted a demonstration trial of a drone (UAV) to assess the drone's performance in updating the aerial photos as required. The autonomous drone shoots a series of pictures along a preset flight path over the local terrain, and is thus capable of conducting a very efficient survey over a wide area. It does however have a number of drawbacks: the operator must have a certain amount of training to deal with problems that occur, and the drone can only fly within visible range of the operator on the ground.

In addition to the drone, we are also evaluating a LiDAR (Light Detection Detection and Ranging) system over part of the city for possible adoption as part of the *Satoyama Maniwa Forest Development Project* that was launched earlier this year. LiDAR is a surveying technology that provides highly accurate data on canopy heights, biomass, and species of forests by scanning the target terrain with multiple lasers.

By introducing these technologies over the entire Maniwa region, this will give us a far more detailed and accurate picture of our forest resources, permitting better stewardship and strategic logging of Maniwa forestlands.

4. Revitalization of Maniwa with ICT: Forestry × IoT = Regional Revitalization of Japan

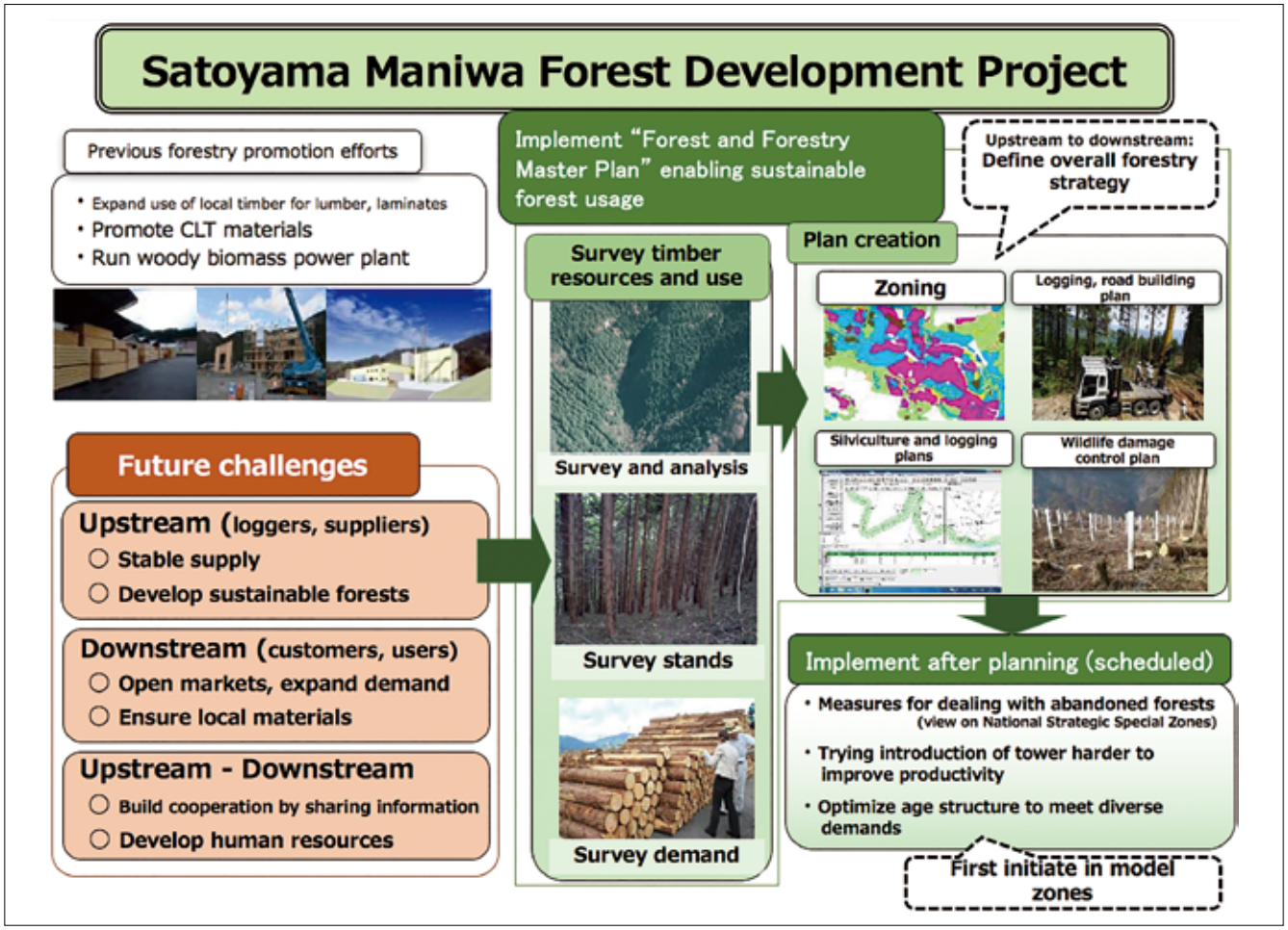
It has now been over three years since Maniwa began adopting ICT into its forestry management. Today, collection of forestry-related data on the cloud and by drone and other aircraft are largely taken for granted at the Maniwa City Office and the Forestry Cooperative. We know of some cases where local communities did not follow through with ICT after it was introduced through government programs and initiatives. In Maniwa, however, local residents were well aware of the benefits ICT could bring to its local forestry, probably because local operators had a long history of working with the government in solving local issues, and immediately began to build practical systems and put ICT into service in tangible ways.

Bringing ICT to Maniwa opened up enormous opportunity for the city to exploit its forest resources. In April 2015, the city completed a woody biomass power plant which provides an output capacity of 10 MW, more than enough to power all of the households in Maniwa. The plant consumes roughly 350 tons of small-diameter logs and slash per day, so clearly requires a stable supply of these logging products. ICT helps secure this supply of woody biomass through the Forest and Forestry Cloud and supply-chain management for biomass coming in from other sources.

With our ability to clearly visualize Maniwa's forests through the Forest and Forestry Cloud, we are now better able to strategically manage these resources, extract sustainable wealth from local forestlands, and this year we began drafting a "Satoyama Maniwa Forest Development Project - Maniwa Forest and Forestry Master Plan" so we can pass these resources on intact to the next generation. By partnering with Sumitomo Forestry Co., Ltd., the largest timber company in Japan, our goal is to create a model of forest management that can serve as a revitalization showcase for rural communities throughout Japan. The reason we can pursue this ambitious challenge is that Maniwa's basic forestry management data is largely digitized, so it can be readily analyzed and used for secondary purposes.

And Maniwa's commitment to ICT is not confined to just exploiting the city's forest resources. European countries with far higher per capita GDPs than Japan have moved aggressively to leverage ICT in their timber industries, and this has clearly contributed to the extraordinarily high productivities of these countries in forestry. For example, in Austria they have

Figure 3: Satoyama Maniwa Forest Development Project - Maniwa Forest and Forestry Master Plan



implemented real-time supply-chain management with land owners, loggers, and sawmills linked over a network and cloud technology. Another case in point is Denmark, where they have set up local heat supply systems in various places throughout the country that use wood chips, sawdust and other waste from lumbermills to heat homes and public institutions, and typically these systems use an ICT called smart metering for monitoring and billing purposes. Moreover, homeowners can easily adjust the temperature and amount of heat used in their homes using their smartphones.

ICT also shows enormous promise for safety management in logging operations. Cell phone reception is poor or nonexistent in mountain valleys, so what happens when you have an emergency, say an accident involving a chainsaw or heavy machinery? I believe the answer can be found in wireless network technologies. These technologies work even in places where conventional ICT cannot be implemented, and wireless networks are becoming more robust even as they continue to fall in price.

5. Conclusions

Over this past decade, the cloud and networks and sensors have continued to find increasing applications in the forestry sector, especially as their performance has improved and their prices have moderated. Maniwa is an excellent case in point, and the city's initiatives have played a crucial role in this development. The fact that the cloud and networks and sensors yield better performance at lower cost has really opened the way to the Internet of Things (IoT), and widespread penetration of IoT will only bring good news to those those rural communities struggling to revitalize their local economies by exploiting forest resources.

Cover Art

Hanaogi of the Ogiya (Ogiya Hanaogi), from the series Renowned Beauties Likened to the Six Immortal Poets (Komyo bijin rokkasen).

Kitagawa Utamaro (1753-1806)