Figure 14.1 - We need to get communities involved not only in technologies but also in planning all aspects of restoration.

Figure 14.2 - Safety is most important issues when promoting drone use. Here, village children flee as the eight propellers of a wayward prototype double quadcopter career towards their shins.

Chapter 14

SOCIAL, ECONOMIC AND LEGAL ISSUES OF AUTOMATED FOREST RESTORATION

Pimonrat Tiansawat[1], Jacob Zott[2] and Prasit Wangpakapattanawong[3]

ABSTRACT

Practitioners often concentrate most on the technical aspects of forest restoration and less on the social aspects, whilst often ignoring legal aspects. Social considerations include involving all stakeholders in planning, tree planting or tending natural regeneration, and monitoring. The most important legal considerations are usually concerned with land tenure. Automation will most probably further complicate both social and legal aspects of forest restoration. Social acceptability of the use of unmanned aerial vehicles (UAVs) and the other technologies, described throughout this volume, will undoubtedly be subject to much debate. Communities may well develop their own "no fly zones" such as sacred sites etc. Use of UAVs is subject to, and may be restricted by, a rapidly growing number of new regulations, particularly those focussing on the critical issues of safety and personal privacy. Social norms and laws vary widely among countries and are rapidly evolving. Therefore, this review highlights just some of the currently emerging socio-economic and legal issues that may impact the implementation of automated forest restoration (AFR). Those proposing novel AFR methods, should consider such issues simultaneously with the development of new technologies, so that AFR projects can be planned and implemented with minimal legal problems and social disruption.

Key words: community, socio-economics, sacred sites, unmanned aircraft systems, security, privacy, drone law

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SOCIAL AND LEGAL DIFFERENCES BETWEEN CONVENTIONAL AND AUTOMATED FOREST RESTORATION (AFR)

The science and technology of forest restoration has advanced considerably in recent years (DELLASALA et al., 2003; ELLIOTT et al., 2013). However, less attention has been paid to the legal and social aspects of such activity. DELLASALA et al. (2003) argue that, in addition to enhancing ecological integrity, good ecological restoration depends on three main principles i) sound ecological science, ii) effective ecological economics and iii) support from communities, including a motivated, incentivized, work force. When considering the automation of forest restoration tasks, new and additional cultural factors (e.g. beliefs) may come into play, for example, flying UAVs over off-limit areas, such as sacred sites, may offend some communities. Automation may also alter the economics of restoration, particularly employment of villagers in formerly labour-intensive tasks. Legal aspects, concerning land tenure, are similar for both automated and conventional forest restoration and have social dimensions, particularly the restoration of communal lands. However, the use of UAVs opens up a whole new area of potential legal problems, centred around safety and privacy concerns.

During the workshop, group discussion on social and legal issues, participants highlighted the following questions:

1. What are benefits of AFR to local communities?
2. Sense of local ownership – would local people be more or less willing or able to participate in AFR, compared with conventional forest restoration?
3. Would AFR displace local employment opportunities?
4. Would AFR open up new local training and employment opportunities, such as operating drones, manufacturing “seed bombs” etc.?
5. How might development of AFR benefit from local knowledge, e.g. knowledge of terrain, tree species used and use of local materials and services?
6. Might AFR affect local sensibilities in ways that conventional forest restoration does not, e.g. flying drones over sacred lands?
7. Would AFR skills and technologies have any spin-off benefits for local agriculture?
8. Would AFR require different models of stakeholder engagement, compared with conventional restoration?

SOCIAL ISSUES OF AUTOMATED FOREST RESTORATION

Socio-economic indicators for forest restoration

Effective forest restoration projects have both ecological and socio-economic benefits. Ecological benefits include biomass (and carbon) accumulation, the diversification of forest structure and the recovery of biodiversity and ecological functioning, with the consequential return of a vast range of forest products and ecological services, both to local communities and downstream stakeholders. Socio-economic benefits flow from revived forest products and services, either when they are perceived to have socio-political values (e.g. strengthening land tenure) or when they start to yield cash income. EGAN & ESTRADA-BUSTILLO (2011) developed indicators for assessing the socio-economic outcomes of forest restoration projects. The most highly rated indicators were related to job creation, community stability, economic impacts and collaborative participation in forest restoration processes.

Immediate restoration costs (e.g. planting stock, transport, labour, fertilizer, etc.) play a major role in influencing the type of restoration strategy that local stakeholders select. The implementation costs of forest landscape restoration are highly site-specific (REUBEN, 2015). AFR, reduces some restoration costs (e.g. labour, nursery running-costs etc.), whilst also generating new costs. UAVs are currently quite expensive and they have short life spans, but prices are declining rapidly and durability is getting better. Entry-level quadcopters, with very basic cameras, can be bought for less than $100, whilst more sophisticated drones, with high resolution cameras and advanced navigational and object-avoidance technologies, start at around $1,000. Prices depend on flight time, rotors, size, weight, camera quality and control/navigation systems. The costs of permits to fly should also be factored into overall costs (ATTKISSON, 2016). Using drones, to drop seeds passively into inaccessible restoration sites, could be achieved at relatively low cost, probably more cheaply and safely than employing human labour to plant trees. However, more complex AFR tasks, such as seed collection or weeding, depend on advanced imaging or sensing technologies, which are still very expensive.

Land tenure

Land tenure is probably the most important socio-legal consideration when planning all forest restoration projects, whether conventional or automated.

Involving land owners (and all those who may have other rights to the land or control access to it) in forest restoration planning and implementation ultimately determines the long-term fate of restoration projects. This is because those stakeholders with local land rights are most immediately affected by forest restoration, either positively (e.g. benefits from forest products and environmental services) or negatively (e.g. crop production foregone) (OVIEDO, 2005). However, AFR requires additional considerations concerning land. Space will be needed for UAV take-off and landing, storage and maintenance facilities, if not on the restoration site itself, then a short distance away.

Figure 14.3 – UAV technologies have agricultural applications. Hmong villagers (in northern Thailand) showed great interest during a demonstration of a crop-spraying UAV, during the workshop

Collaborative participation

In general, participation depends on people's interests in forest restoration. With conventional forest restoration, getting people to work collaboratively is challenging, because much of the work involves hard labour. Human labour is required, from seed collection, to tree planting and maintenance. On tree-planting days, it is common to see some people simply giving up, when carrying baskets of seedlings up steep slopes, leaving such arduous tasks to a few strong people. On the other hand, for AFR, use of UAVs requires highly trained personnel. For villagers, the learning curve is steep. If they are interested in AFR, they will have to invest lot of time in training, before being able to operate AFR technologies. Despite the learning challenges, UAV technologies are likely to stimulate participation in forest restoration, because of their novelty and entertainment value (Fig 14.1). Villagers may also recognise that training in UAV operation has applications in agriculture. One experience we had during the workshop was that villagers showed great interest when small UAVs that are capable of spraying crops were demonstrated (Fig. 14.3). The villagers were willing to let the pilots fly UAVs over their land and demonstrate their capabilities. The attractiveness of the new technologies may be able to promote collaborative participation and acceptance of forest restoration projects.

Cultural no-fly zones?

Different countries impose various airspace restrictions. Restricted areas (no-fly-zones) typically include civil and military airspace (Federal Aviation Administration, 2016) and they tend to be imposed near airports, hospitals, power plants and around the venues for national and/or international events. It is mandatory for UAV operators to be aware of where not to fly and flight software often blocks take off in such areas. In addition to no-fly-zones, recognized by the government, some areas are spiritually sensitive and regulations regarding UAV flights have not been established.

Sacred spaces can include man-made religious monuments (e.g. temples, burial grounds) or natural places of religious or spiritual significance (e.g. mountains, rivers etc.) (Gale, 2005). About 15% of the world's surface is considered to be sacred (Alliance of religion and conservation, 2016). Certain actions are sometimes prohibited in such holy or sacred places. For example, in some cultures, it is considered inappropriate for women to enter certain sacred sites. Consequently, the likely cultural reactions to the possibility of UAVs flying near or over such sensitive areas must be carefully explored with local stakeholders when planning AFR projects (Fig 14.4). Furthermore, certain tree species may also be considered of spiritual significance, depending on local beliefs. Some may be regarded as the home of good or evil spirits, whilst others may yield products that are used in religious rituals. This may affect species choices, when planning which tree species to plant, whether seeded from drones or planted as seedlings.

Figure 14.4 - A sacred ground has a spiritual significance. In this photo, a Hmong villager performs a ritual in the forest. AFR practitioners must consult with local stakeholders to determine which practices are appropriate when considering flying over or implementing other forest restoration tasks in or near sacred sites.

Tapping into indigenous knowledge for (automated) forest restoration

In additional to helping with the cultural and spiritual aspects of species selection, local villagers should also be involved in other aspects of tree species selection. If following the framework species approach, the selected tree species should have reasonably high survival and growth rates, when planted out in the hot dry sunny conditions that typify open, deforested sites. They should have dense spreading crowns, to shade out weeds, and produce edible fruits or nectar-rich flowers to attract seed-dispersers. If such information about local native forest tree species is incomplete, indigenous knowledge can be of immense value. Local people know first-hand which tree species tend to recolonize abandoned fields (fast-growing pioneers), which are most attractive to seed-dispersing wildlife and optimum seed collection times. They are also very much aware of which species have local economic uses that would increase the acceptability of restoration projects among the local population (ELLIOTT et al., 2013). Indigenous knowledge of herbs and grasses may also play a part in developing effective auto-weeding methods. Local people may become involved in helping to develop weed species recognition software and they may help with the development of weeding regimes that draw on their knowledge of weed phenology. Thus, even though AFR will undoubtedly be based on cutting-edge technologies, traditional local knowledge has much to contribute and mechanisms must be developed to facilitate dialogue among scientists, engineers and villagers beginning with the development and planning stages of AFR (Fig. 14.5).

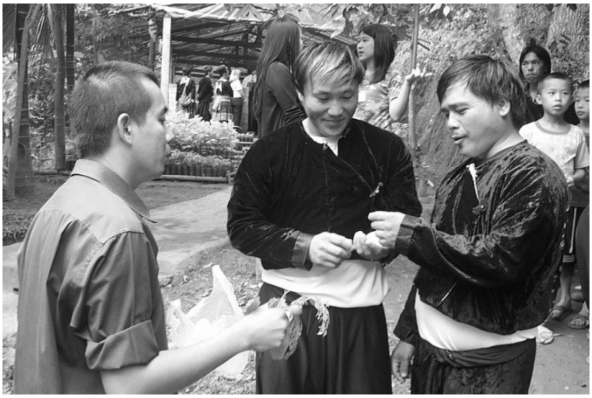


Figure 14.5 – Working with indigenous people enables local knowledge transfer.

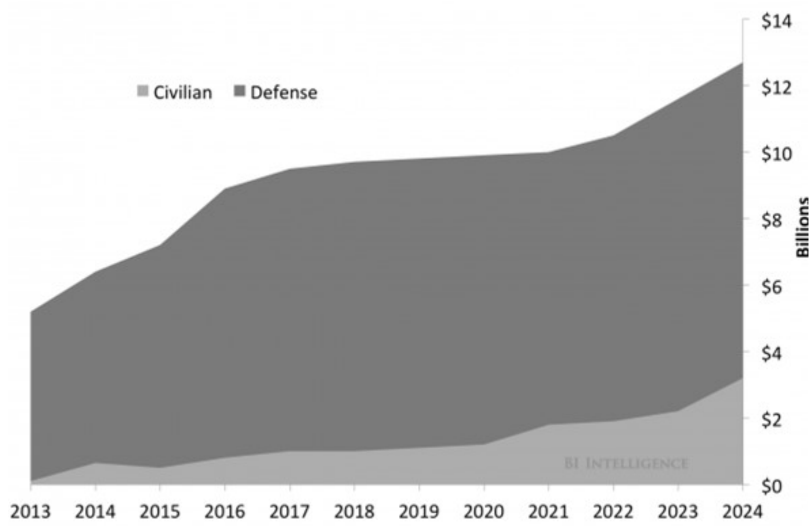
Pros and cons of conventional and automated forest restorations

Introducing new technologies that may replace conventional methods of any activity requires time for people to learn, adjust and adapt. Even though UAVs have been used for various purposes (ranging from aerial photographing to parcel delivery), their use for forest restoration is new. Therefore, the development and testing of new AFR technologies should occur concurrently with exploration of the social, political and economic aspects of using such technologies. This not only increases the chances that modern technologies will be accepted by local stakeholders, but might also provide training and employment opportunities for villagers and shorten the length of time needed for adjustment and adaptation.

LEGAL ISSUES CONCERNING USE OF UNMANNED AERIAL VEHICLES (UAV)

The rapid rate of development of UAV technologies continues to outpace the formulation of legal regulations. Historically, UAVs have been primarily used for military purposes e.g. for combat (bombing) and intelligence gathering. Hence, their use has been subject to military regulations. However, as the technology becomes cheaper, more easily available and user-friendly, UAVs of various sizes are now available for commercial and recreational (civilian) use. Worldwide, at least 441 companies are involved in UAV manufacturing (UAV Global, 2016). The civilian UAV market is predicted to grow by 19% annually from 2015 to 2020 (BI Intelligence, 2015). Increased use of UAVs, since 1980 (Fig. 14.6) has given rise to concern about two important issues: i) safety and ii) privacy.

Figure 14.6 - Forecast of global growth of the civilian and military UAV markets (Sources: Teal Group, BI Intelligence Estimates, Michael Tascano)



YEAR

Safety

Safety issues include UAVs injuring people (Fig. 14.2) and damaging aircraft, which in turn potentially threatens lives. The safety issues reviewed here exclude those posed by military drones, which often target people. UAVs may crash into and injure people unintentionally, when batteries or guidance systems fail, or when structural failure renders the drones uncontrollable. Intentional injuries can occur when controllers deliberately fly UAVs into people or aircraft. In recent years, use of UAV-mounted cameras to film public sporting events has become commonplace, but UAVs pose hazards to both athletes and bystanders. In 2013, a drone (1.2 m across), fell into an audience stand and hurt five people at a Bull Run event in Virginia, USA (WEIL, 2013). In 2014, an Australian triathlete was struck on the head by a crashing drone, while running a race in west Australia. The drone was operated by a videographer, who was filming the event (DOYLE, 2014).

Human factors play significant roles in UAV crashes (DEGARMO, 2004). UAV crashes may become less likely as UAV technologies become more reliable and operators gain more experience. However, there is no consensus on standard skill levels that should be required of UAV operators for commercial use (DEGARMO, 2004).

In addition to injuring people, UAVs flown near airports and/or flight paths threaten aircrafts and their passengers. From 2014 to 2015, there were 764 close-call incidents (i.e. a situation in which a collision almost happens) between UAVs and other aircraft (up to August 9th 2015) in the USA (FEDERAL AVIATION ADMINISTRATION, 2015), although only 27 were incidents reported by civilian aircraft pilots; the rest involved military aircraft (JANSEN, 2015). In the United Kingdom (UK), there were 23 close-call incidents around airports during six months in 2015 (April to October). One of the most recognized close-call incidents occurred at London's Stansted Airport in September 2015. The pilot of a Boeing 737 passenger jet reported seeing a 2-meter-wide-UAV, which passed less than five meters above the aircraft's path in controlled airspace (TOPHAM, 2016). Other close-call incidents, involving UAVs, included sightings of small UAVs, when planes were taking off or approaching the runway (e.g. PIGGOTT, 2014; TOPHAM, 2016; UNITED KINGDOM AIRPROX BOARD, 2016). As of February 2016, the number of close-call incidents involving UAVs was six out of a total of 10 close-call incidents (UNITED KINGDOM AIRPROX BOARD, 2016).

Privacy

Privacy concerns are also associated with the use of UAVs, since most of them carry cameras. Before the advent of UAVs, manned aerial vehicles had been used for land mapping, aerial photography, area surveys etc., usually operating at 150 meters or higher above ground level in populated areas (FEDERAL AVIATION ADMINISTRATION, 2015). Therefore, although such aircraft were undoubtedly capable of invasion of privacy, their presence was less perceptible by people on the ground compared with drones. In contrast, UAVs can be operated just a few metres above the ground. They can take really close up and detailed images, even looking sideways into buildings. This capacity for low-altitude hovering and close-up photography has raised considerable public concern about invasion of privacy.

In 2015, a quadcopter evaded security and crash-landed on a lawn of the White House, where the president of the United States resides and works (MILLER, 2015). The UAV operator was not charged. In other incidents, people have protected their privacy by destroying UAVs that they feel have intruded. One incident that shows how threatened people feel by the presence of drones occurred in 2015 in the USA, where a man shot down a drone that was hovering above his property, believing that the UAV was spying on his daughter (VINCENT, 2015). It is therefore likely that public concerns over invasion of privacy will significantly affect the evolution of drone laws and regulations.

Figure 14.7 – Public safety and privacy are less of a concern in unpopulated areas, such as an abandoned agricultural land. In the figure below, a UAV pilot sets up a ground station for flight control systems in an open area to test an aerial seedling device.

Safety and privacy issues of AFR

Although the use of drones for AFR is likely to be seriously impeded by broad rules and regulations, it is unlikely to pose a danger to public safety and privacy, since AFR sites are (by definition) are far from public access and populated areas (Fig. 14.7). Therefore, the use of UAVs for site surveying, seed collecting and aerial seeding is unlikely to interfere with people’s activities (except for the case of sacred grounds mentioned above). However, because UAVs may fly over wildlife habitats, they may affect animal behavior. In the USA, recreational use of UAVs is banned from national parks, because of concerns about disturbing wildlife (UNITED STATES NATIONAL PARK SERVICE 2014). The response of wildlife to drones is highly variable. For example, elephants are either unaffected by them or move away, since the sound is similar to bees, which elephants naturally avoid. This response has been used in Africa to "shepherd" elephants away from crops and danger[2]. In contrast, birds of prey are threatened by UAVs and attack them (ENGELKING, 2015). Further studies of the effects of UAV operation on wildlife are needed for appropriate development of AFR technologies.

DIFFERENCES IN NATIONAL REGULATIONS ABOUT UAVs

At the international level, the UN has yet to formulate standards or guidelines about the civilian use of commercially available UAVs. Therefore, national governments have taken the initiative to create their own rules, in response to the rising growth of UAV use. Consequently, laws that control UAV use vary greatly among countries (Table 1). Countries can be grouped into three categories, according to national regulations regarding UAVs: i) no existing official regulations, ii) relaxed regulations and iii) strict/complex regulations (Table 1). Most African and Asian countries have no drone laws in effect, although some are in the process of drafting and passing such laws.

Countries with drone laws are split roughly equally between those with relaxed regulations and those with more strict or complex regulations. Less strict regulations usually cover where drones may be flown and limit the altitude at which they can be flown. For example, in Finland, drones cannot be flown higher than 150 meters above the ground (FINNISH TRANSPORT SAFETY AGENCY, 2015). Other common regulations, restrict drone flights to good weather conditions during daylight hours or stipulate how far away they must be kept from airports (e.g. LATVIA CIVIL AVIATION AUTHORITY, 2006).

Countries with relaxed regulations include, for example, Paraguay, Uruguay and Latvia. Those with stricter or more complex rules include the Philippines, Malaysia and Thailand. Such regulations usually involve registration of drones, limit their size or stipulate training of drone pilots.

In the Philippines, all UAV equipment must be registered with the Civil Aviation Authority of the Philippines (CAAP) (CIVIL AVIATION AUTHORITY OF THE PHILIPPINES, 2015). In order to operate a UAV, operators must be certified through a complex process that includes: prior practice, a training course and either a flight crew license or an air traffic control license. Military certification equivalent to operation certificates is also acceptable.

[2] wildtech.mongabay.com/2015/05/drone-herders-tanzanian-rangers-and-researchers-use-uavs-to-protect-elephants-and-crops/

In Malaysia, UAVs must meet or exceed the safety and operational standards established for manned aircrafts. Drones are also not allowed to endanger people or property (in the same way as for manned aircraft). All UAV operators must hold a Private Pilots' License before operating UAVs and receive authorization from the Department of Civil Aviation to fly UAVs heavier than 20 kg (DEPARTMENT OF CIVIL AVIATION OF MALAYSIA, 2008).

In Thailand, UAV use is categorized into: i) recreational use and ii) research and commercial use. Use of UAVs for research requires the submission of flight plans to the authorities and the issuing of permission prior to use. Pilots must register with the Thailand Civil Aviation Authority. UAV users must also have third-party-liability insurance, with coverage of 30,000 US dollars or more (THAILAND'S MINISTRY OF TRANSPORTATION, 2015).

Table 1 - Summary of national regulations of UAV uses of top 15 countries with the most serious forest cover loss

Country (Ranking by percentage of forest loss)	Forest loss (%) (2001-2012) relative to tree cover in 2000*	Legal regulation of UAVs
Mauritania	43.8	No official regulations
Malaysia	14.8	Strict/Complex
Portugal	14.8	No official regulations
Uruguay	12.7	Relaxed
Paraguay	12.1	No official regulations
Cambodia	10.9	Strict/Complex
Latvia	10.4	Relaxed
Saudi Arabia	10.4	No official regulations
Guatemala	9.7	No official regulations
Argentina	9.2	Relaxed
Indonesia	9.0	No official regulations
Nicaragua	8.9	Relaxed
Sweden	8.4	Relaxed
Finland	8.2	Relaxed
United States	7.9	Strict/Complex

*Source: *HANSEN ET AL., 2013*

Effects of legal regulations on development of AFR

The practicality of using UAVs for AFR is affected by legal regulations. Strict, complex regulations are likely to slow down AFR development. Restrictions on where UAVs can be flown may have little impact on AFR, because the technique targets less accessible areas with low population densities. On the other hand, regulations on how UAVs may be flown may have a much more restrictive effect.

In Thailand, the law stipulates that pilots must be able to see UAVs throughout the entire duration of flights. Pilots are not allowed to use a UAV's camera for navigation i.e. autonomous flight is not allowed (THAILAND'S MINISTRY OF TRANSPORTATION, 2015). However, the regulations allow room for negotiation on a case-by-case basis. If the processes of getting permission to use UAVs and register flight plans are time-consuming, the use of UAVs in AFR research may be paralyzed.

To further develop UAV technologies for AFR, ecologists and technologists must develop mechanisms to influence policy makers – to clearly explain the benefits of AFR technologies for restoring forest ecosystems and re-establishing flows of products and ecological services therefrom. They must also be pro-active in suggesting sensible regulations that deal with the actual dangers of working with UAVs, whilst also addressing the less tangible concerns that arise from the uncertainties that surround the introduction of new technologies.

Communicating effectively with the general public will be critical in determining whether or not AFR technologies are widely adopted. When a wide range of stakeholders have been convinced of the values of AFR and of sensible, but not overly restrictive regulations, they may be able to lobby governments to enact laws that encourage and support AFR, rather than stifle it.

Box 14.1 - Additional questions to consider before planning AFR

- Are people more likely to participate in AFR than in regular tree planting?
- Who will be using AFR?
- Who could fund the research and implementation costs of AFR?
- Does local knowledge, e.g. local weather, local terrain, benefit AFR?
- Could plastic and metal, in AFR technologies be replaced by biodegradable materials?
- Who will be responsible for any accidents caused by AFR operations? e.g. herbicide drift on to crops or UAV crashes into people or buildings.

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