

# The shifting place of Australian *Acacia* species around the world: Adoption, uses and perceptions

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## Abstract

From ornamentals and rehabilitators to resources and invaders, Australian *Acacia* species (wattles) have assumed diverse roles over time in the varied landscapes to which they have been introduced. The reception of these species – linked to how they are used, to peoples' perceptions about the trees and shrubs' place in particular a landscapes, and to the environmental and socio-economic context – changes over time. In a context where wattles are sometimes important economic resources, sometimes subject to concerns over invasion, and where the climate emergency leads to pushes for rapid tree planting, the question is raised of how the place of wattles in human landscapes may evolve into the future. We sought to identify recent trends in how wattles are welcomed (or not), used (or not), and managed (or not) by people around the world. A conceptual model is proposed to understand how and why wattles are adopted and perceived differently in different places; this highlights moments of large, rapid, irreversible, and systemic change, or regime shifts. We undertook a limited global online survey involving 72 respondents with knowledge on different wattle landscapes. Respondents were asked about changes in wattle extent, use, impact, perception, and management over the past 10-15 years. We found that wattle social-ecological systems are dynamic: respondents reported more change than stability. They noted more wattle expansion than shrinkage; a number of increased uses; mostly amplifications (and some reductions) of previously reported impacts, both good and bad; generally increased awareness

of invasions; and they commented on a number of management efforts both for forestry and for invasion control. Some changes are major and irreversible, such as the conversion over two decades of at least 6% of Vietnam's land area to wattle plantations and accompanying institutional, economic, social, and ecological shifts. Others are more incremental and perhaps reversible, such as public perception of environmental risks linked to wattles. Trends are different across the main regions reported on, namely South Africa, Europe, southeast Asia.

## 16.1. Introduction

Australian *Acacia* species (wattles) have been moved extensively around the world by humans over the past 250 years. Seeds have been exchanged and widely disseminated for purposes ranging from botanical curiosity to ornamental gardening, and from land rehabilitation to commercial forestry. This has created a massive global-scale experiment providing opportunities for gaining insights on factors that influence the ways that different introduced species have been assimilated into ecosystems, human cultures, and value systems and how these factors change over time and under different circumstances (Richardson *et al.*, 2011).

Introduced wattles play diverse roles in the lives, livelihoods and economies of people and communities around the world. Yet peoples' interactions with wattles are not uniform and are shaped by the geographic and ecological context, people's needs and individual preferences, policies in force, economic opportunities, and ideas circulating about these 'exotic' trees. Furthermore, peoples' relationships with wattles evolve, sometimes slowly, sometimes quickly, in response to diverse factors.

Over a decade ago a previous study investigated the diverse ways in which wattles are valued, used, adopted, and perceived around the world (Kull *et al.*, 2011). It showed that differences across countries and regions were explained by biology and environment (which wattle species, what environment were they growing in, how invasive they were), by the social and economic context (people's subsistence needs, the presence of markets, the structure of land ownership, prevalent ideas concerning the environment, and economic development levels), and by people's familiarity with the trees (related to why and how the trees were introduced, knowledge and skills transfer, length of time that wattles have been present, and their proximity and abundance). The study described eighteen wattle landscapes around the world, and grouped them into four situations: (1) places where poor rural communities host agroforestry project interventions that encourage wattle planting, like in Dominican Republic, Ethiopia, Niger, and Republic of Congo; (2) places where poor people take advantage of wattles as a resource already widespread in their landscapes, like in Madagascar, India, or farm labourers and residents of communal lands or informal settlements in South Africa; (3) places with a formal forest products industry, involving households and businesses alike, as in Brazil, Chile, South Africa, and; and finally (4) rich country communities dealing with the legacies of former or niche use of introduced wattles,

and rarely reliant on wattles for domestic uses, like in France, Hawai‘i, Israel, La Réunion, and Portugal.

A subsequent study (Kull *et al.*, 2017) investigated the nature of “regime shifts” in wattle landscapes, noting different types of major, sudden, and persistent changes in the patterns, functions and processes perceived to characterize the situation of wattles in a particular place. These could be material changes (economic or biological) as well as conceptual (e.g., changing perceptions) and be described in the past, or ‘wished for’ in the future. A major example of such a regime shift is the twenty-fold increase since 2000 of wattle plantations in Vietnam, coincident with major policy changes, leading to the radical transformation of the livelihoods and identities of numerous rural residents. Another example is the change in environmental and social policy following the end of apartheid in South Africa, leading to the Working for Water program that pays indigent people to remove woody invasive plants like wattles and pines from watersheds. Other changes are much more incremental, slow, or marginal, and do not qualify as regime shifts. For instance, new concerns over biological invasion, while pertinent for managers of natural reserves, have hardly affected the public’s views of wattles in southern France.

The present chapter builds on these previous studies, with the objective of identifying shifts and trends in how wattles are used, perceived, and managed in the landscapes in which they grow wild and/or in managed stands around the world in the last 10-15 years. In a context (a) where wattles are important economic resources in many places, (b) where concern over invasion by wattles into natural ecosystems or impacts on other economic and non-economic activities and sentiments (e.g., sense of place) have gained much attention, and (c) where global concern over climate change leads to policy pushes for carbon-stocking tree planting like ‘trillion trees’, we aim to provide an overview of trends and upcoming issues related to wattles globally.

## **16.2. Conceptual framework**

How people value wattles is a complex outcome of historically and geographically contingent processes that integrate plant ecology, economic development, political context, and culture. First, wattles have been introduced and propagated in different eras for diverse motivations. These might be linked to their utility for rural development, for specific industrial products, for land rehabilitation and/or restoration, or for aesthetics (Kull and Rangan, 2008; Carruthers *et al.*, 2011). Second, introduced wattles grow in landscapes that present a variety of

environmental constraints and opportunities. Soils, climate, extant vegetation, and land uses shape whether the trees take hold and proliferate, or remain rare, and how they do so. Third, human use of the wattles is shaped not only by the initial reason of introduction and propagation, but by changing economic opportunities and needs for certain products, by rules and traditions governing peoples' access to land and species, as well as ideas about the species, rooted in cultural preferences and evolving scientific and policy discourses. Together, these coupled social and ecological factors shape contemporary uses and perceptions of the species (Shackleton *et al.*, 2019a, b; Yapi *et al.*, 2023) and their extent, role, and influence in regional ecologies (Kueffer, 2017). Kull *et al.* (2011) proposed that the key differences in terms of use, relative levels of reliance, and perceptions of wattles result from a combination of three categories of factors:

1. *Biophysical characteristics and environment*: the particular wattle species and its biological characteristics; the nature of the surrounding environment; the resulting 'behaviour' of the wattle;
2. *Social context*: subsistence needs; specific commercial markets; structure of land tenure; prevalent environmental discourses; policies; and development levels;
3. *Familiarity and knowledge*: original purpose and character (e.g., direct vs accidental) of introduction and accompanying infrastructure, knowledge, and skills transfer; length of time in particular environment; abundance and proximity to people.

These factors that shape the welcome and use of wattles are not static. They continue to change, whether gradually or dramatically. New policies, new markets, or receptive environments for wattle invasion are examples of factors that can lead to dramatic changes in wattle landscapes. Kull *et al.* (2017) explored the value of the concept of 'regime shifts' as a tool to understand social-ecological changes. They defined regime shifts as "... a major, sudden, and persistent change in the tightly interrelated patterns, functions and processes that are perceived to characterize and/or maintain particular society-environment phenomena of interest" (p. 32-33). This definition emphasizes four aspects: speed (sudden, abrupt), scale (dramatic, large, non-linear), stickiness (persistence, difficult to reverse), and systemic (tightly interrelated patterns, processes, and functions). Using wattle landscapes, they show that the concept is a useful tool to analyze both material and conceptual shifts, from the analysis of the past and the present to the normative future.

It is important to understand regime shifts in wattle landscapes as they point to the leverage points which may lead to these shifts. A "regime shifts" perspective emphasizes the

inter-dependence of diverse causal factors and highlights changes that may become irreversible. As a result, the present chapter seeks to identify recent global and regional trends and shifts in the presence of wattles in landscapes around the world and how they have been welcomed (or not) and used (or not) by people.

We bring together and integrate the conceptual proposals of the two previous articles (Kull *et al.*, 2011, 2017, to illustrate the contextual factors shaping wattle extent, use, impacts, perceptions, and management over time and across space, and altered by regime shifts (Fig. 16.1). One could imagine, for instance, this figure representing the story of a place like South Africa. The first regime shift at time point  $t_1$  in Fig. 16.1 was the introduction of wattles through British colonial networks for economic botany, reforestation and woodfuel; the second regime shift at  $t_2$  was the booming mining economy fuelling demand for timber and thus widespread investment in plantations of wattles (among other trees);  $t_3$  was the arrival of apartheid and international trade boycotts which gave further impetus to plantations for self-reliance in wood products (Owen and van der Zel, 2000); and finally,  $t_4$  was the appearance and conjoining of the poverty and water security agendas in post-apartheid South Africa through programs such as Working for Water (Van Wilgen and Wannenburg, 2016). The figure finishes, on the right, by justifying the survey questions we asked of interlocuters around the world which we describe further in the next section.

### **16.3. Methods**

We undertook an email and internet-based survey of people around the world who are familiar with one or more places where alien wattles grow, whether they are landowners, environmental managers, scientists, officials, or interested public. This brief survey of ‘wattle experts’ consisted of six open questions on changes to the presence, use, impact, perception, and management of wattles in the landscape they are familiar with (Appendix 16.1). The survey included a disclaimer stating that responses are voluntary and will not be compensated, that respondents do not have to complete all questions, and that responses would be kept anonymous. The survey (and invitation email) was prepared and made available in the following languages: Chinese (traditional & simplified), English, French, Italian, Portuguese, Russian, Spanish, and Vietnamese, and was open for responses during the entire month of February 2022. It was circulated in the authors’ personal networks, to all co-authors of our previous review (Kull *et al.*, 2011) as well as all authors of articles citing that

piece (140 citations from Web of Science supplemented by Google Scholar, accessed 28 January 2022). The invitation email was also circulated in the networks of the Centre for Invasion Biology (Stellenbosch) and the European Group on Biological Invasions (NEOBIOTA).

Seventy-two (72) completed surveys were returned. Responses that reported on more than one case were separated into two separate entries for analysis (bringing the total to 74). Two responses were subsequently excluded during the analysis, as they did not pertain to non-native wattles. Survey locations strongly reflected generalized regional interest in, and concern over, alien wattles, notably with 23 entries for South Africa, nine for Portugal, and seven for Vietnam (Table 16.1; Fig. 16.2), and few returns for many other locations. Results also reflect the relative differences in extent of our research networks (which are global, but denser in South Africa and Vietnam for instance). Most surveys were returned in English, but several other languages were represented (Table 16.1). No surveys were returned in Russian (despite our targeting of information on *A. dealbata* populations near the Black Sea), nor in Chinese (likely due to blockage of Google in China, but also a lack of awareness according to one email correspondent). Notable weak responses, despite a known presence of wattles as well as our efforts to disseminate the survey in these places, included Chile, France, and India. Most respondents were researchers/scientists (Table 16.1), reflecting the networks used but also the very specialized nature of our survey topic.

## **16.4. Results**

### **16.4.1. Changes in extent**

Of the 63 responses to the question on observed changes over the last 10-15 years in the extent, density, or abundance of wattles, most (70%) stated that there had been clear increases in the region reported about. Only 5% reported cases where there had been declines in the extent or abundance of wattles, although 10% described situations where the respondent had observed both increases and decreases through time, related to either management actions or differences between species. One in six (16%) of the responses indicated that there had been no changes in the extent of wattles over the period of interest.

The numerous cases reporting an increasing extent or abundance of wattles can be easily differentiated between those reporting on commercially driven expansions in plantations and small-grower programmes, from those covering expansions in wild populations, i.e., self-propagated invasions of new landscapes. A third context was mentioned

covering an increasing presence in some urban areas [Italy (*A. dealbata*) and South Africa (*A. saligna*)], most notably in residents' gardens and in disturbed sites. Increasing areas under plantations or on small-grower farms were described mostly from Southeast Asia, including Brunei, Indonesia, Myanmar and Vietnam (Fig. 16.2b), dominated by plantings of *A. auriculiformis*, *A. mangium* and hybrids of these two, but also in Brazil (same suite of species) and Ethiopia (*A. saligna*). These expansions were driven by government programmes and NGOs with an emphasis on commercial supplies and income generation for rural farmers. As yet, there is very little mention of any invasive populations established via escapes from these commercial initiatives.

In contrast, many respondents from a diversity of contexts and regions described increasing extents and/or densities of wild populations of wattles invading natural, semi-natural or disturbed landscapes over the last 10-15 years. Many responses described wattle landscapes in South Africa, covering multiple species, and expressing concerns about invasions into riparian zones particularly. But there were also accounts of invasions into rangelands, disturbed sites, croplands, homesteads and urban areas. Reports from Portugal and Spain related to *A. dealbata* and *A. melanoxylon* invasions into various landscapes, aided by fire and disturbance (Fig. 16.2a). In Italy, *A. saligna* was reported to be invading coastal regions, which is the same in Uruguay but for *A. longifolia*. In Hawai'i, *A. confusa* and *A. mearnsii* were reported to be increasingly invading current and former ranches and cultivated lands. An entry from Fiji covered the invasion of *A. mangium* into grasslands there.

Only three cases of declining extent were reported. Pathogens were implicated in declines in plantations and wild populations of wattles in Southeast Asia (*A. mangium*) and South Africa (*A. mearnsii*). Whilst in Niger, declines in *A. colei* were attributed to it being a short-lived species that requires intensive management and because, lacking clear markets, the species was not favoured amongst farmers. More spatially explicit cases were provided from four countries which illustrate the need to consider wattle dynamics at a local scale. For example, in South Africa some observations were made of declining populations in some regions due to the Working for Water programme and biological control, but in other regions wild populations were rapidly expanding. The same was argued for Portugal where control of invasive *A. longifolia* populations has been successful in some regions, but where the species continues to expand in other areas (Chapter 27, this volume). In Israel, the extent of several species is expanding, but there have been some successes in reducing the extent of *A. saligna*. An interesting case in Brazil covers the transformation of some wattle plantations to soybean fields, but in other areas, wild populations grow unchecked.



The numerous submissions from South Africa show the spatial complexity of wattle dynamics over the last 10 – 15 years. There were multiple reports that in some regions wild invasions are expanding rapidly and density is increasing, due to the absence of any control initiatives and perhaps reduced subsistence use resulting from greater accessibility of electricity over the past 15 years (Fig. 16.2d). Yet, in other parts of the country the expansion of wild populations has been kept in check by the Working for Water programme, or there have been actual declines in extent (and perhaps density) due to control efforts (physical and biological) against some wild populations and the impacts of pathogens on wattle plantations. However, it was also commented that some declines resulting from the efforts of the Working for Water programme were subsequently reversed in situations where there were insufficient follow-up actions.

#### **16.4.2. Changes in use**

Seventy-one responses were provided to the question about changes in use or uses, of which six reported that there was no use of wattles in their region. Of the remaining 65 responses, half (51%) reported that there was no change in the use of wattles over the past 10 – 15 years. In other words, the extent and patterns of use have remained similar to what has prevailed over a long period. The other half reported one or more changes in use, with 24 (37%) saying that it had increased for some products, and eight (12%) saying that it had decreased for specific reasons.

Decreases in use were tied to decreases in extent by some observers. For example, declines in extent were due to pathogens for *A. mangium* in SE Asia and *A. mearnsii* in some parts of South Africa (also see Nasution *et al.*, 2019). A decrease in use of *A. dealbata* and *A. melanoxylon* in Spain was attributed to their use being declared illegal. Reportedly *A. dealbata* was used to provide poles for vineyards, but that is no longer the case. The remaining cases all came from South Africa, where it was speculated that there was declining use amongst rural, subsistence populations due to a combination of urbanization on the one hand, and the increasingly availability of electricity to rural households, which presumably has decreased demand for fuelwood. One commentator attested to a decline in large-stemmed individuals of *A. dealbata* and *A. mearnsii* in the Eastern Cape as they were being selectively removed to supply commercial timber mills or the high-income barbeque market.

Increases in use were described across a variety of regions and species, some directly observed, whilst others are in the planning stages but are anticipated to result in increased use. Likely increases in use were linked to reports of new processing mills in Ethiopia,

biochar and firewood for the barbeque market in South Africa and *A. mangium* and hybrid *A. mangium* x *A. auriculiformis* plantations in Myanmar. A wide range of increased uses were observed, ranging from aesthetics in European countries to industrial developments on several continents and subsistence uses in some parts of South Africa and Fiji (Table 16.2).

### 16.4.3. Changes in impact

We asked about the effects of wattles on people, nature, and landscapes. Of the 64 valid responses to this question, 22 said there were no changes and 42 mentioned changes. In half of the latter cases, a change in impacts was not explicitly mentioned, but could be implied due to mention elsewhere of an expansion, densification, or reduction of wattles. In general, the changes in impacts were either decreases or increases in impacts already reported before the 10 - 15 year period, rather than new impacts, or impacts of a different character or underlying nature. Changes mentioned were quite diverse (summarized in Table 16.3); we elaborate below on key categories. With respect to impacts on livelihoods, six responses were from Vietnam (Fig. 16.2b), where wattles have increasingly significantly contributed to improving people's lives. This includes both direct income from cultivation of own land and indirect income (hired labour, transport, and processing). Conversely, in Sumatra, large industrial plantations of wattles were blamed for appropriation of customary lands and thus loss of access to land and livelihoods. Projects in Africa specifically designed to improve livelihoods of subsistence farmers showed both positive effects (in Ethiopia, *A. saligna* is increasingly being used for diverse agroforestry and livelihood uses like fodder, poles, chicken feed, especially because of the 2016-2017 drought) and no effects (in Niger, there was a lack of uptake of introduced *A. colei* despite years of promotion by NGOs).

Regarding aesthetics, in four cases the ornamental use and attractiveness of alien wattles in landscapes was maintained and unchanged (France, Ghana, New South Wales and Uruguay). At the coast of Uruguay, for instance, the season of yellow wattle blooms during the grey of winter weather is associated in many peoples' minds with the season of whale-watching. Seven cases mentioned changes in aesthetics due to an increased presence of wattles. These include two urban cases (Venice, Italy and Boa Vista, Brazil) and five rural cases (four in South Africa and one in Spain). Some observers ascribed normative judgements to these changes (several 'bad' and one 'good'); another noted that the public may have different perceptions from scientists.

Impacts on biodiversity were frequently seen as increasingly negative due to factors such as decreased ecosystem functioning, habitat loss, or competition. These concerns

emerged in most regions. For instance, regarding habitat loss, two Vietnam cases mentioned the conversion of natural forest to wattle plantations (Fig. 16.2b), a South African case from the Eastern Cape province described wattle replacing palmiet (*Prionium serratum* (L.f.) Drège) wetlands and fynbos vegetation, a Portugal case wrote of landscape alteration, and the Hawai‘i case mentioned the negative effects of wattles on restoration of native vegetation.

Water resources were mentioned most frequently in South Africa, regarding either reductions in water yield and flow due to growth of wattles in watersheds, or the improvement of hydrological health due to removal of wattles. One response from Portugal and two from Vietnam reported similar observations. Other changes with respect to water included a change in taste and colour of water in wells and streams after the creation of an *A. mangium* plantation (Roraima, Brazilian Amazon), and the effects of riverbank wattle invasions on stream morphology that aggravate erosion and flooding (South Africa).

Interestingly, responses regarding impacts on land and soil were all reporting from the humid tropics. Negative changes were notably mentioned in Vietnam related to wattle plantation activities, ranging from a reduction in soil productivity after 2 or 3 harvest cycles, to soil damage due to practices like fire and cleaning, and to increased erosion risk and landslide susceptibility. Contradictorily, wattles were lauded for leading to land rehabilitation (once in both Fiji and Ethiopia and thrice in Vietnam), due to their nitrogen fixing capacity and as a vegetation cover helping soil conservation. In Fiji, the wattle plantations were seen to be helpful for the regeneration of native species and bird habitat.

#### **16.4.4. Changes in perceptions**

Of 59 relevant responses, 14 said there were no changes to perceptions of wattles, four mentioned perceptions but did not specify if there was a change, and 41 mentioned changes. Most of these implied gradual changes rather than regime shifts. An exception is a respondent writing about Agulhas in the Western Cape province, South Africa, who stated that there has been a major public opinion shift about wattles especially from a biodiversity perspective. One of the Vietnam responses likewise mentioned that there was “a big change in the perception of both advocates and opponents”.

The most common type of perception that was mentioned (in 32 responses) was awareness of negative environmental impacts of the wattles. Some noted insufficient awareness, with no change (Italy, Portugal, Republic of Congo). Others mentioned decreasing awareness - that it has “dropped off the immediate concern radar”, and that the media and government were no longer concentrating on wattles (Eastern Cape province,

Drakensberg foothills in South Africa). The majority (23) claimed that awareness had increased. A dozen of these were reporting on South Africa, with some mentioning the awareness-raising efforts of government programs (like Working for Water) and local NGOs. Three mentioned the impacts of recent droughts in increasing awareness about the impacts of wattles on water resources, and one linked increased awareness to the large fires of 2017 in the southern Cape, which were seen to be fuelled by alien plants. Four respondents from Portugal likewise mentioned increased awareness linked to information programmes and the impacts of fires. Three respondents mentioned increased awareness of negative impacts in Vietnam, especially after recent problems with flooding and landslides and encroachment into natural forest, but all noted that people are also extremely aware of the major economic role of wattle plantations (also see Chapter 25, this volume).

Positive perceptions of wattles concerned aesthetics, NGO projects, and economic interests. The public appreciates wattles for their floral beauty and landscape aesthetics; this was mentioned for Italy, Spain, and Uruguay, however no change in this appreciation was noted. Humanitarian and development NGOs promoting the planting of wattles in dryland regions of Africa for land rehabilitation, firewood, and food also work to create positive perceptions. Respondents mentioned that local peoples' perceptions of wattles were either unchanged after decades of project work (Maradi, Niger: "still open to growing and using acacias") or increasing (northern Ethiopia: "people seemed more interested or curious" perhaps due to the 2016-2017 drought, but also due to government promotional campaigns and visible outcomes). Changing economic perceptions of wattles were mostly reported in the cases of tropical wattle plantations. For instance, while initially sceptical or involved in wattle growing just due to government pressure and wage opportunities, rural Vietnamese residents have since the 2000s become strongly interested in wattle as a source of income and joined the rush to plant wattles, expand those plantations, and increase the economic benefits from the industry (Fig. 16.2b). A response from Myanmar echoes those of Vietnam, saying "people want to plant", and that investors were applying for land grants from the government (before the coup). In Fiji, the respondent asserted that despite initial concerns, farmers have come to value *A. mangium* for its utility as fuel and for beekeeping, and its use for soil amelioration.

Scientific attention was mentioned 11 times. The Ethiopian cases highlighted the large role of research in promoting *A. saligna* for land rehabilitation and evaluating its impacts. The rest of the cases addressed the science focused on wattle invasions. Four responses noted that scientific attention to diverse aspects of wattles in the landscape and their impacts had

increased (Italy, Spain, and twice Portugal). One respondent noted that the ascendant global agenda for tree planting due to the climate emergency (initiatives like “Trillion Trees”) was a challenge for those trying to remove wattles and restore grassy and shrubby ecosystems.

Media both reflects and shapes public awareness. Seven survey results mentioned the media. Three noted that media attention to problems caused by wattles had increased (Eastern Cape province in South Africa, Portugal, Spain), two specified media attention to wattle’s economic potential (Myanmar, Vietnam), and two noted decreased attention by the media to either wattle problems (KwaZulu-Natal province, South Africa) or potential (Roraima, northern Brazilian Amazon). The latter noted that farmers (in association with the government) were replacing wattle plantations in the local savanna landscape with soybean cultivation in recent years, and as such there was all around decreasing attention to the wattles (among scientists, local people, and the media).

#### **16.4.5. Changes in management**

When asked whether they had observed any changes in the management of wattles, of 63 valid responses, 20 specified no change, 11 did not indicate whether change had occurred or not, and 32 implied that some form of change had occurred. Prompted by our question, categories of changes that were noted included new rules, new projects or activities, new cultivars, new biological control agents, and new techniques, but respondents also mentioned diverse shifts in funding, harvesting programs, silviculture, and certification (Table 16.4).

Some of the changes mentioned have the potential of being – or at least leading to – relatively major and long-lasting changes (thus, regime shifts). For instance, rules regarding dissemination or obligations to control certain species can form part of a regime shift (but, as respondents from Spain noted, only if they can be successfully implemented and enforced). Another example is the increased success of biological control methods in South Africa. One respondent writing about the Table Mountain area near Cape Town was quite insistent, noting that

“Biocontrols are having a major impact. Due to the introduction of a fungus *A. saligna* increasingly now die early, are wimpish and hardly produce seeds - compared to 20 years ago when they were magnificent trees that trashed large areas of Fynbos. Similarly, large mountainsides invaded with Longleaf Wattle (biocontrol a wasp) are now largely clear of the species. Similarly, *A. cyclops* and [*A.*] *mearnsii* (biocontrols: midges) now hardly ever set seeds...”

In Vietnam, where government agencies are largely behind the initial promotion of wattles for land rehabilitation and subsequent plantation economy boom (Chapter 25, this volume), attention is turning among experts towards questions of better management and sustainability, including encouragements for longer cultivation cycles and certification programs.

## **16.5. The nature of change in wattle landscapes**

The situation of wattles – their spread and human interactions with them – entered a rather dynamic phase some two centuries ago when they were repeatedly introduced to new places around the world. In each landscape, this dynamism continues – as governments or development agencies promote new introductions and economic uses, or as environmental managers seek to control those plants that have become too successful. We sought to characterize the dynamics of wattle extent, use, impacts, perceptions, and management in the past 10 to 15 years, and have demonstrated that things have not stayed still.

Before drawing some broader conclusions, several caveats are in order. Our findings arise from an exploratory, qualitative survey, which – as noted earlier – is based on a non-representative sample of ‘experts’. As such, assertions we report would need further triangulation, and are best seen as leads for further research. Furthermore, it should be noted that the distinction between listing uses, impacts, perceptions, and management actions – *versus* listing *changes* to use, *changes* to impacts, *changes* to perceptions, or *changes* to management over the last 10 - 15 years was rarely explicit in survey responses. This means that we may have imputed more changes than can empirically be documented.

Several trends and changes emerge from the survey, especially if the results are contextualized by world regions exhibiting similar trends, geographies, histories, and socio-economic conditions (Table 16.5). The most obvious, major regime shift is the establishment of vast wattle landscapes in places like Vietnam where there were none only a few decades ago, leading to fast shifts in extent, use, impacts, perceptions, and management (Chapter 25, this volume). Changes in other places are smaller – either more localized, like to a specific project intervention in a particular subregion, or typically more incremental, such as changes to public opinion, use or management in wattle landscapes with longer histories. Time and magnitude play a role in the differences between these regions: while wattles are a recent, yet very major, phenomenon in Vietnam (Chapter 25, this volume), they have been in Europe

(Chapter 10, this volume) and South Africa (Chapters 12 and 26, this volume) much longer. Attention to wattles boomed in South Africa in the 1990s together with concerns over water resources and poverty, leading to awareness and management approaches that are arguably more mature than in Europe, where attention has been more scattered.

A sub-theme emerging from the survey results is the relevance of ‘trigger events’ in leading to changes. Respondents across countries mentioned specific droughts, floods, and fires as key moments in their regions, particularly in shifting public perceptions. However, the impact of such events may be ephemeral. More persistent ‘change factors’ were also mentioned that might provide repeated pushes in certain directions. These could include rural electrification (which, if affordable and maintained, could reduce demand for wood fuel and release tree populations); or biological control (which should reduce the vigour and spread of invasive plants).

Changes are occurring, but how we discuss them is in the eye of the beholder. For example, scale matters: the clearance of a small watershed of wattles may be a ‘regime shift’ for the farmer just downstream, but irrelevant at a national scale if not part of a broader program. Table 16.6 uses the four elements of a definition of ‘regime shift’ to characterize three examples of changes and trends from the survey results. It shows that it is easier to label Vietnam’s national wattle boom a ‘regime shift’ than a more sectoral intervention such as South Africa’s biological control program (despite its successes) or Europe’s wattle invasions. Table 16.6 also shows that these wattle situations are truly integrated social-ecological phenomena (Kueffer, 2017), with the factors causing stickiness being linked to human actions, institutions, and paradigms and wattle biology, and with systemic effects across the social-economic-political domain as well as across ecologies and landscapes.

Wattle social-ecological systems will certainly continue to evolve towards the future. A warming climate may allow wattles to expand further into temperate Europe, leading to novel encounters, uses, and management challenges (Branquart *et al.*, 2018). Pathogens may restructure south-east Asia’s approach to farmer woodlots and industrial plantations. A new ecological paradigm may displace invasion science and reshape public views. But the story will largely unfold at local scales – along this fence line, on that dune, on that plot of land – where people and plants will shape the landscape of the future.

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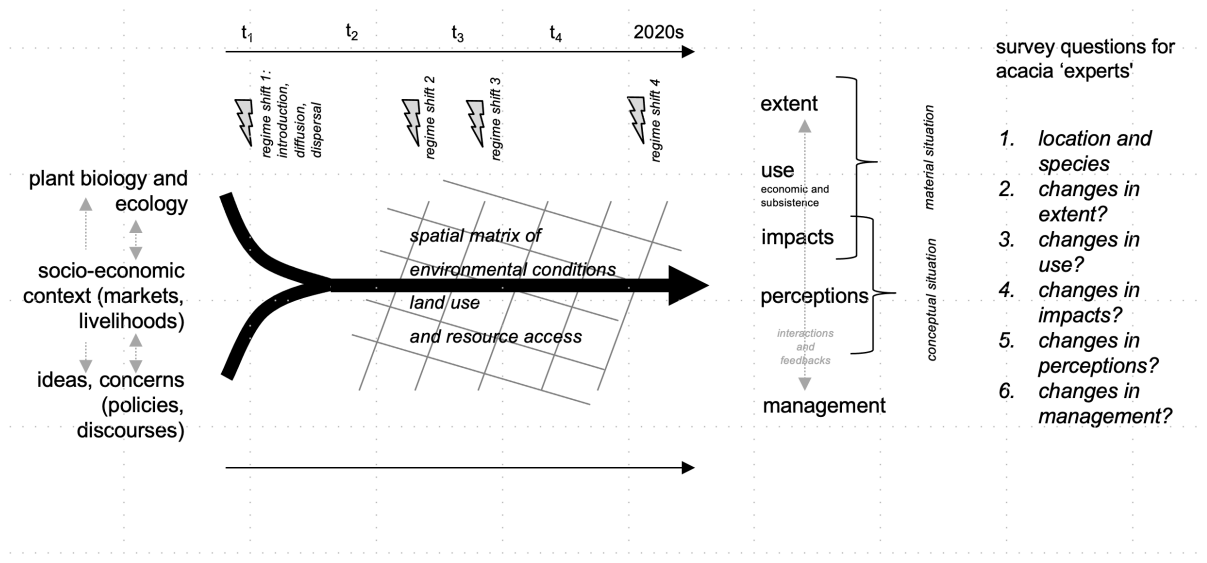


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**Figure 16.1.** Factors and regime shifts affecting extent, use, impacts, perceptions, and management of Australian *Acacia* species.



**Figure. 16.2.** Scenes of wattle adoption discussed in the chapter. Clockwise from top left: (a) escaped wattles at a touristic site in Viana do Castelo (north Portugal), seat of a district with large-scale invasions; (b) patchwork of wattle woodlots outside Hue (central Vietnam) and access road expanding into degraded natural forest areas; (c) wattle products on display at the Fête du Mimosa in Mandelieu (southern France); (d) wattle plantations and invaded patches in Ekulindeni (Mpumalanga, eastern South Africa). Photos: C. Kull (a, b, d) and M. Fernandes (c).



**Table 16.1.** Description of returned surveys about Australian *Acacia* species.

Locations (n=74)	#	Respondent type (multiple responses possible)	#	Language (n=72)	#
<b>Sub-Saharan Africa</b>	<b>29</b>	Researcher/scientist	55	English	47
...South Africa	23	Government official	9	Portuguese	10
...Other (2 Ghana, 2 Ethiopia, Rep. Congo, Niger)	6	Environmental manager	8	Vietnamese	6
<b>Europe &amp; Mediterranean</b>	<b>21</b>	Owner/manager of wattle land	7	Spanish	4
...Portugal	9	Economic user of wattles	3	Italian	3
...Spain	4	Amateur naturalist	2	French	1
...Italy	4	Interested resident or visitor	2	Russian	0
...other (France, Turkey, Israel, Algeria)	4	Other	12	Chinese	0
<b>South and Southeast Asia</b>	<b>14</b>				
...Vietnam	7				
...Other (2 Brunei, 2 general SE Asia, Myanmar, Indonesia, Nepal,)	7				
<b>Americas</b>	<b>6</b>				
...South America (2 Brazil, Uruguay, Chile)	4				
...California	2				
<b>Australia/Pacific</b>	<b>4</b>				
...Pacific (Hawaii, Fiji)	2				
...Australia	2				

**Table 16.2.** Reported increased uses for specific purposes of Australian *Acacia* species by country and species.

General use category	Specific uses	Region and associated species
Beautification	Festivals	France/Corsica (multiple species)
	Ornamental	Italy ( <i>A. dealbata</i> ); Switzerland ( <i>A. dealbata</i> )
	Urban planting	France/Corsica (multiple species)
Industrial/commercial use	Bark	South Africa (multiple species)
	Charcoal	South Africa ( <i>A. decurrens</i> , <i>A. mearnsii</i> )
	Pulp	South Africa (multiple species); Vietnam (hybrid <i>A. mangium</i> x <i>A. auriculiformis</i> )
	Timber	Brazil (unstated); Vietnam ( <i>A. mangium</i> )
	Woodchip for thermal energy	Portugal (unstated)
Restoration	Restoration/rehabilitation	Ethiopia ( <i>A. saligna</i> ); Fiji ( <i>A. mangium</i> ); Vietnam ( <i>A. mangium</i> )
Subsistence	Firewood	Fiji ( <i>A. mangium</i> ); South Africa (multiple species)
	Poles	South Africa ( <i>A. mearnsii</i> )

**Table 16.3.** Reported types of changes to the impacts of Australian *Acacia* species (wattles) on people, nature, and landscapes.

<b>Type of impact</b>	<b>Mentions (of which a change specified)</b>	<b>Notes</b>
Livelihoods	13 (9)	(see text)
Pests	2 (2)	<i>Ceratocystis</i> in Vietnam; 'African bees' in Roraima state, Brazil
Security and criminality	4 (4)	Wattles provide hiding places for criminals who prey on livestock or on passers-by in South Africa
Allergies	2 (2)	Pollen allergies in Portugal
House damage	2 (2)	Damage to foundations and walls in South Africa
Croplands and rangelands	5 (5)	Weeding and associated costs in Hawaii, Israel and South Africa
Aesthetics	11 (7)	Aesthetic impact maintained or increasing around the world (see text)
Biodiversity	21 (19)	Widespread reporting of negative impacts (see text)
Water resources	12 (12)	Reduced water due to invasion (or conversely improved hydrology after removal), notably in South Africa (see text)
Fire	8 (7)	Increased fire risk due to wattle expansion in South Africa and Portugal, decreased risk due to wattle removal in South Africa, or wattle fire breaks in Fiji
Land and soil	7 (7)	Degradation due to wattle plantation practices (see text)
Rehabilitation and restoration	7 (7)	Some reliance on wattle for land rehabilitation (see text)

**Table 16.4.** Notable recent changes in Australian *Acacia* species management, according to respondents.

Country	Type	No. of Responses	Details
South Africa	Law	1	2004 National Environmental Management: Biodiversity Act (NEM:BA), specifies species for control or permits
Spain	Law	2	2007 Transport of plants, propagules, or seeds of <i>A. dealbata</i> , <i>A. salicina</i> , and <i>A. melanoxylon</i> becomes illegal
South Africa	Funding	5	Declining resources for control activities, monitoring, and enforcement (disruption to tender process; COVID impacts)
Portugal	Funding	1	More public funding for wattle control
Diverse	Physical and chemical control and restoration activities	11	General increase in activities (Israel, Italy, Portugal, South Africa) or experimentation with techniques, such as: <ul style="list-style-type: none"> <li>• stacking wattle branches on contours and in gullies against erosion (Eastern Cape)</li> <li>• use of fire (Eastern Cape)</li> <li>• care with herbicide use around sensitive wetlands (Eastern Cape)</li> <li>• use of livestock as bioturbation tool for grassland restoration (Eastern Cape)</li> <li>• linking wattle management to water source protection (Eastern Cape)</li> <li>• ring-barking and base-peeling (Mpumalanga; Portugal)</li> <li>• sap pulling and saline injection (France)</li> <li>• new herbicide (Israel)</li> </ul>
South Africa	Biological control	7	Introduction of <i>Dasineura</i> gall midges (cf. Post <i>et al.</i> , 2010) and several suggestions that such control methods were having an increasing impact
Diverse	Harvesting programs	3	<ul style="list-style-type: none"> <li>• Fiji: <i>A. mangium</i> cut for fuelwood and replaced by cropfields (replacing previous pastures of flammable alien grasses).</li> <li>• Eastern Cape: NGO partnership with WWF is trying to develop a value chain for wattle as a free raw material.</li> <li>• Portugal: company using wattle woodchips to produce thermal energy to heat two retirement homes</li> </ul>
Brazil	Commercial plantations	2	Contradictory trends: increased commercial reforestation projects (Rondonia) vs. pulling out of a forestry project and its replacement by a new agribusiness sector (Roraima)
Southeast Asia	Cultivar selection	3	Continued genetic work to improve cultivars for <i>A. mangium</i> and <i>A. mangium</i> x <i>A. auriculiformis</i> hybrids
Vietnam	Sylviculture	5	Promotion of longer harvesting cycles (from 3-5 years to 7-10 years, for larger timber)
Vietnam	Sylviculture	2	Nascent efforts at intercropping with native tree species
Vietnam	Certification	3	Growth in use of sustainability certification programs (like Forest Stewardship Council) for wattle plantations

**Table 16.5.** Generalization of changes to extent, use, impacts, perceptions and management of Australian *Acacia* species over the last 10-15 years reported by respondents across the three regions representing the most numerous responses.

	<b>South Africa</b> (respondents strongly focused on invasion and control)	<b>Europe</b> (respondents focused on invasion and aesthetics)	<b>Southeast Asia</b> (respondents focused on plantation forestry)
<b>Extent</b>	Many local increases and some local decreases	Many local increases and some local decreases	Massive expansion
<b>Use</b>	Ongoing (perhaps decline due to electrification, rural depopulation); other economic uses	Unchanged, generally limited use	Strong growth in wattle wood products economy
<b>Impacts</b>	Continued impacts on biodiversity, fire, and water	Localized impacts on ecology or fire risk reported	Improved livelihoods and growth of forestry sector in national economy; negative impacts of plantations (erosion, forest encroachment)
<b>Perceptions</b>	“Mature”: wide awareness of invasion and impacts; debates over management	Increased science, awareness efforts, and perception that there is problem (especially Portugal)	Focused on economic benefits; nascent attention to downsides and risks
<b>Management</b>	NEM:BA legislation (2004); biological control agents; diverse control actions	Spanish law (2007); Portugal funding for control; diverse control actions	Policy encouragement; silvicultural innovation; certification programs



**Table 16.6.** Are recent changes in wattle extent, use, impacts, perceptions, and management of Australian *Acacia* species consistent with the idea of a ‘regime shift’? Illustration using examples from text.

<b>Criteria</b>	<b>Vietnam’s vast wattle plantations</b>	<b>South Africa’s biological control program</b>	<b>France/Italy wattle invasions</b>
<b>Scale</b> ( <i>dramatic, large, non-linear</i> )	<b>Yes.</b> Significant at a national scale (6-9% of land cover)	<b>No.</b> Some advances, new introductions	<b>No.</b> Locally yes, but relative stability in perceptions and use
<b>Speed</b> ( <i>sudden, abrupt</i> )	<b>Yes.</b> Since 1990s, accelerating 2000s	<b>No.</b> Perceived as gradual over decades	<b>No.</b> Presence since centuries; concern over invasives slow to take hold
<b>Stickiness</b> ( <i>persistence, difficult to reverse</i> )	<b>Likely.</b> Livelihoods linked to wattles; economic infrastructure built around timber; institutions in place; seed bank in soil	<b>Yes.</b> Biological control agents well established in landscape	<b>Likely.</b> Seed banks, public non-concern, climatic limits
<b>Systemic</b> ( <i>tightly interrelated patterns, processes, and functions</i> )	<b>Yes.</b> Diverse policies (land rights, economic, environmental), livelihoods, markets, and landscapes	<b>Yes.</b> Links also to government funding, other control measures, land use changes...	<b>Yes.</b> Policies, ecology, land use...

## Appendix 16.1. Text of the survey instrument (English version)

1. What acacia landscape will you describe: what PLACE or REGION, and which KIND of acacia (species)?

The next five questions ask whether you have observed important changes in the past 10-15 years concerning acacias in your landscape. Please tell us about those changes. What changed, when, why? Is the change quick or slow? Is it steady or accelerating? Relative to 10-15 years ago, how big was the change (estimate the number of times larger or smaller)? If there have been no changes, please say so and interpret why.

2. Have you observed any changes in the EXTENT AND CHARACTERISTICS OF ACACIAS IN THE LANDSCAPE? (for instance: number of trees, density or area covered, places they grow, health, ecological characteristics...)

3. Have you observed any changes in USES OF ACACIAS? (for instance: who uses acacias, how they use acacias, type of use, size of harvest, number of people, extent of reliance or dependency...)

4. Have you observed any changes in THE EFFECTS OF ACACIAS ON PEOPLE, NATURE, AND LANDSCAPES? (good or bad impacts: biological, social, aesthetic, economic...)

5. Have you observed any changes in PEOPLE'S PERCEPTIONS AND UNDERSTANDINGS OF ACACIAS? (for instance: public awareness and appreciation, criticism, media attention, scientific attention, conservation attention).

6. Have you observed any changes in THE MANAGEMENT OF ACACIAS? (for instance: new rules, new projects or activities, new cultivars, new biocontrol agents, new techniques...).

Finally, tell us about yourself. What category of 'expert' are you? (Tick as many boxes as you wish)

- environmental manager
- economic user of acacias
- owner or manager of land with acacias
- government official
- interested resident or visitor
- researcher/scientist
- amateur naturalist
- other