Israel's New Bible of Forestry and the Pursuit of Sustainable Dryland Afforestation

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After several decades of dramatic reform in forestry practices, the Keren Kayemeth L'Yisrael (KKL) compiled the new orientation and specific management changes in a comprehensive policy entitled the Forestry Bible. While Israel's foresters originally planted monoculture "pioneer" pine plantations, the new orientation calls for diverse, indigenous, naturally regenerating woodlands and their rich suite of ecosystem services. Timber production has been downgraded and is not to be a priority for Israel's dryland forests. Maximization of ecosystem services with a particular emphasis on recreation and conservation drives much of the present strategy. The article highlights the evolution of Israel's forestry policies and details the new approach to afforestation and forestry maintenance along with its rationale.

Key words: *Forest, Israel, Keren Kayemeth L'Yisrael, pine trees, oak trees, ecosystem services.*

Restoring the vast natural woodlands destroyed during the past century constitutes one of the primary challenges for the world's environmental community. The most accurate estimates place the total loss of total forest area on the planet since the advent of agriculture eight thousand years ago between forty (*Millennium Ecosystem Assessment, 2005*) and forty-seven percent (Billington et al., 1996). Many countries have begun ambitious afforestation efforts that are starting to slow the net annual total loss of global forestlands (Nambiar, 2005) even as regrettably, old-growth forest destruction continues apace.

While international attention tends to focus on tropical and temperate reforestation, dryland areas, that comprise 47% of the planet, are also areas where afforestation is urgently needed. Indeed, tree planting is a critical component in international efforts to combat desertification (Adeel et al., 2005). Several countries with large dryland regions, including China, Spain, Greece, Nigeria, Turkey, South Africa and Australia have begun substantial afforestation efforts.

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Despite its small dimensions Israel is a country characterized by a steep rain gradient. Some 97% of its territory is defined as drylands with either hyper-arid, arid, semi-arid or dry sub-humid climates. But much of the land naturally was still able to support rich forest ecosystems. Anyone familiar with the Bible knows that woodlands used to be an integral part of the countryside. Pollen samples, archaeological findings, ancient texts and centuries of travel reports confirm that trees thrived throughout the northern half of this ancient land even as late as the crusades (Tal, 2013). Yet, during the course of the past thousand years, the country's forests were decimated by a combination of warfare, overgrazing, harvesting for fuel and even intentional arson and sabotage. By the time of Israeli independence in 1948, only 2 percent of the original woodlands remained forested (Weitz, 1974).

With the advent of Israeli independence, afforestation became a major national initiative. It was driven by both a desire to address the pervasive unemployment associated with massive immigration of Jewish refugees and to fulfill an ideological mission of "restoring" a damaged promised land. Within ten years of receiving independence, the Israeli government forestry agency and the Jewish National Fund (a public corporation that in 1961 was formally authorized to serve as Israel's forestry service) planted large areas of the country's northern and central regions. The trees planted during this energetic, inaugural period were largely conifer monocultures based on Aleppo pine trees (*Pinus Halepensis*). Today, these plantations comprise a full 33% of Israel's present forests. Eventually, in 1995, a National Master Plan for Forests was approved by Israel's government zoning 162,000 hectares of lands as forests. This area was over a hundred thousand more hectares than planners had originally envisioned, covering close to a tenth of all land in the country (Kaplan, 2011).

It did not take long for the first generation of Israeli forests to encounter a range of problems. Pest infestation became rampant, wood quality was low and the forestry methods and assemblage came under increasing criticism as destructive to indigenous biodiversity. By the 1980s, different approaches to forestry emerged and the KKL started on a brave, uncharted path towards sustainable forestry in drylands. A series of landmark dates are worth mentioning in this context. In 1990 the new practices were spelled out in a thin best practices guide that was Mordechai Ruach, then head of KKL's, land development department (KKL, 1990). For example, the guide determined that trees were to be planted at a far lower density than had previously been commonplace. Another landmark was the aforementioned adoption of a National Masterplan for Forests (Masterplan 22) by Israel's National Planning Council. The Masterplan defined several types of forests and mapped them across the country (Kaplan, 2011). In 2006, the organization's board of directors adopted a new general policy of sustainable forestry. Six years later, this policy was officially codified in a new document entitled The Bible of Afforestation in Israel, Policy and Directives for Forest Planning and Management - hereinafter the Bible of Afforestation (Osem et al., 2012).

Eight years in the making, the Bible of Afforestation constitutes a concise compilation of the collective wisdom that accrued to the organization over the past thirty years as Israel's foresters left "pioneer" pine plantations for diverse, indigenous, naturally regenerating woodlands and their rich suite of ecosystem services. The changes in orientation and methods that have occurred over the past twenty years are dramatic (Ginsberg, 2000) yet frequently remain unknown or misapprehended by observers (Amir, 2006). This article presents some of the major shifts in paradigms and practices as they are articulated in the country's new, comprehensive forestry policy.

Although Israel's forests are small by international standards, they have been successfully cultivated on degraded lands, frequently with extremely modest precipitation. The lessons learned during the trial and error process are valuable for the many dryland nations who face the daunting task of restoring the vegetation to eroded lands whose chronic aridity will only grow worse due to climate change. The Bible of Afforestation offers practical specifications for countries who wish to leap to the top of a learning curve and avoid the pitfalls associated with poorly considered monoculture plantations.

After reviewing briefly the process that culminated in the publishing of the Bible of Afforestation in 2012, several central components of the policy will be discussed including:

1. New objectives for Israel's forestry program;
2. Density of planting;
3. Diversity of tree assemblage;
4. Utilization of herbicides;
5. Post-fire management strategies; and
6. Involvement of the public and surrounding communities.

By describing how and why these positions evolved, the economic, ecological and social advantages associated with Israel's new procedures and specifications emerge, offering a clear direction for sustainable forestry programs conducted under dryland conditions.

WRITING A NEW TESTAMENT

Israel's forestry program's initial phases were largely a "trial and error" process that was only intermittently recorded. Beginning in the 1920s, for some fifty years Yosef Weitz oversaw forestry in the Jewish National Fund. Although not a trained forester, he was an extremely gifted autodidact and was involved in all stages of the planting process. Most of the operational decisions made during the country's first thirty years were based on his intuition and remarkable memory. Even as it was designed as a history tome, his book Forests and Afforestation in Israel (published in Hebrew in 1968 and updated to English in 1974) is the closest document to a formal policy from the period that emerged.

Soon after Weitz's retirement, concepts and axioms in the JNF began to change with the emergence of a new generation of foresters who brought academic backgrounds to their work and who were better informed by principles of applied ecological and conservation biology. It would take another thirty years before a process began that sought to articulate the new approach in formal policies. First, the JNF board appointed a sub-committee for sustainable development which prepared a series of documents to ensure that the organization operated according to principles of sustainability. Its position paper for forestry: Afforestation Objectives: The Preservation of Diverse and Sustainable Forest That Offers Services to the Public, published in 2007, remains in force today. It sets forth a series of general principles which prioritizes indigenous diverse stands, lower tree density and active public participation. But the document by design is short on specifics which could clarify the specific management practices expected of foresters in the field.

The new *Bible of Afforestation* was launched by Yisrael Tauber soon after his promotion to director of the Forest Management Department of JNF. During an annual field trip of foresters in 2004, he was intrigued by a debate between two schools of foresters regarding the intensive thinning that had been done in a forest in the Judean Hills. One perspective thought that a crime against the forest had been committed while the other thought the low density stand was an appropriate and optimal way to take care of the forest. Yet, there was no authoritative source which could resolve the competing perspectives.

Tauber decided that a "Bible" needed to be created containing a comprehensive, sustainable forestry policy, and insisted that the chairman of the JNF board write a formal letter authorizing the process. He also determined that the document should be written by internal JNF staff and not outsourced. A steering committee based on a variety of internal professionals associated with forestry was created and then divided into three different teams to work on separate sections: planning; planting; and management of mature forests.

Relying on senior staff to oversee the process made a great deal of sense in theory. Yet, the day-to-day exigencies which they faced in their work and their heterogeneous orientations led to a series of delays. Ultimately, the materials produced were collected by Tauber, Jerusalem Mountain forester Hanoch Zoref and academics Avi Pervolotsky and Yagil Osem who completed an initial draft of the *Bible of Afforestation* in 2010. The text was circulated and reviewed in a hearing attended by a range of academics, NGO representatives and foresters on May 12, 2011 at the forestry branch headquarters in Eshtaol, after which myriad comments were submitted. At the start of 2012, eight years after the process begun, a final draft was ready for adoption and implementation. The sixty-six page document is written in clear, simple Hebrew with almost an intentional attempt to avoid professional jargon. It balances between general policy principles and technical specifications for afforestation activities. Almost every aspect of forestry is addressed.

FORESTRY OBJECTIVES

Israel's original foresters were immigrants, largely of European origin, who had clear ambitions about creating a profitable timber producing resource. For example, in a 1952 textbook about Israeli woodlands, Dr. Israel Gindel, a forestry researcher trained in Warsaw, envisioned afforestation to be a central division within the Israeli agricultural economy, once the weak quality of timber was upgraded (Gindel, 1952). Yosef Weitz, the father of Israel's forests was particularly keen on the Aleppo pine species because it grew so quickly and promised to provide a significant percentage of local timber needs (Weitz, 1974).

Unfortunately, these expectations were unrealistic and by the 1980s, timber production had been downgraded as an operational goal for local forests. The new Bible of Afforestation of sets a hierarchy of objectives for the country's forests which includes the following:

1. Provision of recreational services (hiking, enjoying nature);
2. Landscaping and diversifying the scenery;
3. Provision of diverse ecosystem services (carbon sequestration, primary production etc.);
4. Support for Israel's unique biodiversity;
5. Soil and water conservation;
6. Providing communities with a variety of economic assets;
7. Preservation of open spaces;
8. Protection of indigenous species and their repatriation into nature;
9. Preservation and renovation of heritage sites;
10. Ecological restoration of damaged habitats;
11. Creating acoustic barriers; and
12. Increasing the connection between the public with nature, forests and environmental education (Osem et al,, 2012, 3)

In other words, wood is only one of many ecological services that forests provide. Timber production is but a small part of the overall contribution that forests make and rarely if ever drives management decisions. The lesson is clear: once foresters in the drylands are liberated from production schedules and maximization of lumber board footage, forests are to be designed to and nurtured to provide a richer range of services to the public. In general, the Bible of Afforestation creates a new reality for planning. Foresters are required to think ahead for periods of 25 years and manage according to long-term objectives. Israel's forests are to be much more clearly defined according to land use objectives while at the same time, building in a more dynamic process that allows for changes in response to the actual conditions that emerge on the ground. Thus the orientation is defined as an "adaptive goal driven management" approach. Planners work together with foresters and presumably the nearby communities to clearly define the precise activities and uses that they would like to see take place in a given forest – from hiking and picnicking to habitat preser-

vation and pollination support. Once these are defined, the forest is broken up into salient planning units and zoned according to the optimal distribution of activities given prevailing topographic and other conditions (Osem et al., 2012, 19-20).

Four levels of planning are envisioned in this process. At the outset and standing at the top of the hierarchy is a Master Plan, prepared with a 25-year outlook. The Master Plan directs subsequent decisions and priorities in an entire forest or even a series of neighboring forests. Next, a Multi-year Work Program is to be prepared with a 10-year planning horizon, which implements the broader objectives of the Master Plan. This determines the specific activities taking place, the amount of human resource implementation will require and a more specific time table for execution. The next level is an Annual Work Plan which is broken down at the parcel or stand level. This requires not only detailed specifications of the management activities in the area, but also the funds required for implementation. Frequently a Detailed Activity Work Plan will also be prepared which reaches the resolution of monthly detailed specifications that a given forester is expected to complete (Osem, 2012).

TREE DENSITY

The original forests planted during the 1950s and 1960s were particularly dense. In order to provide high quality, marketable timber, trees needed to grow tall and straight. The resulting high density plantings turned the forests into tree farms, designed to facilitate rapid growth of pines that could be harvested within a decade. The trees in these early JNF forests were never separated by more than two meters and density typically reached 4000 – 5,000 trees per hectare (Avni, 2009).

The result was crowded and somewhat sterile stands. Not everybody liked them. By the 1950s, Israel's nascent environmental movement was anything but enthusiastic. Azariah Alon, founder of the country's oldest environmental NGO in Israel, the Society for Protection of Nature challenged the aesthetics and the legitimacy of the forests, writing:

> "*The Jerusalem* (Aleppo, A.T.) *pine may be a native tree, but there's no justification for turning it into the sole species. The dense plantings created a string of negative phenomena: the size of the trees wasn't natural; the Jerusalem pine only grew in height, not in width. An adult tree needs 5 by 5 meters at least, which meant no more than 400 trees per hectare, but in practice, there were 2000 trees or more and sometimes twice that. In theory it might have been possible to plant many and then to cull them down to the desirable number, but in practice, this wasn't to be. Correct thinning needs to be revisited every two years, an impossible task from an economic and manpower perspective, leaving the trees to grow as tall, thin sticks."* (Alon, 1996, 339).

By the 1980s, after a string of disappointments in timber production projects, the forestry branch of the JNF reached the conclusion that initial expectations of a prosperous wood production economy in a water scarce region were unrealistic. Slowly but surely the density of trees planted began to drop. This trend culminated in the 2011 recommended practices published in the *Bible of Afforestation.*

The policy explains that optimal density is ultimately a function of age. In a forest with stands of different ages and multiple layers, each must be addressed separately. Yet, the prevailing inclination in drylands is to create low density forests. For example, for mature trees (until age 40) density should be thinned to 200 trees a hectare (200 seedlings per hectare -- sph). For the younger saplings (until age 10) density still should still not exceed 500 trees/ h. (Osem et al, 2012). Planting in practice today begins with about 1000 sph (roughly 2.5 meters distance between seedlings) in temperate regions, and in semi-arid forests, tree density today starts at a dispersed 100 to 200 sph. These levels are often further reduced during periodic thinning (Osem et al., 2012). This drop of more than an order of magnitude in density has led to forests that are more open and accomodating to human visitors as well as a richer variety of animals and understory.

DIVERSITY

JNF's initial forestry efforts took place before 1948 when the organization was heavily influenced by the much more substantial government forestry program run by the British Mandate in Palestine (Lipschitz and Bigger, 2004). During the period between 1920 and 1948 the fourteen government run nurseries experimented with a variety of trees and generously provided the JNF with free samples. While typically several dozen species (both endemic and exotic) were distributed to government foresters, by the 1930s the most prevalent one selected for planting by the British was the Aleppo pine, which comprised some 30% of all trees planted (Palestine Government, 1936).

The JNF also tried its luck with a variety of tree species, and initially favored Australian eucalyptus trees. But Joseph Weitz, who oversaw forestry during the pre-state period, soon became impressed with the relative advantages of Aleppo pines and their ability to outperform other species under a variety of conditions. Redubbing the species the "Jerusalem Pine", by 1926 50% of 69,335 trees planted in forests by JNF were Aleppos. By 1934 the pine domination increased to 98% (Lipschitz, 1994). This bias continued throughout the 1950s and 1960s so that during the initial tree planting flurry that characterized the first years of statehood, Israel's woodlands were almost entirely Aleppo pine plantations.

Warnings by academic experts about the perils of monocultures went unheeded by management even as pests, such as the pine blast scale, began to devastate local conifer stands (Tal, 2002). Eventually, the collapse of major pine forests near

Jerusalem in the 1970s forced a reappraisal of this strategy. To begin with, Aleppo pine was replaced by the Calibrian pines (*Pinus brutia)* species which the British had begun importing in 1937. By the 1990s, the JNF had changed its orientation entirely, cognizant of the prevailing expert opinion that found Aleppo pine presence to be a relatively minor part of the country's natural assemblage. Oak (*Quercus calliprinos)* and Terebinth (*Pistacia palaestina)* were identified as the original so-called climax species that dominated woodlands as late as the Neolithic periods (Lipschitz, 2007). These slower growing "broad leaf" species were favored by foresters on lands with sufficient rainfall to support them.

The *Bible of Afforestation* integrates this fundamental shift in species preference into its holistic management ideology. Formally, forestry management in Israel is to be informed by ten principles such as an adaptive management approach, designing forests to meet a variety of uses, adjusting assemblage and formation to actual local conditions and habitats, minimum ongoing human intervention and least possible environmental impacts from afforestation (Osem et al., 2012. 3-4). Among this list of managerial themes "diversity complexity and patchiness" is particularly emphasized. The document defines this principle as "Preservation and nurturing of diversity of landscapes, habitats, plant types, species and genotypes in the forest on those lands where formations aspire for diversity of disparate tree types, with wide age spans and with a structure of different vegetative levels." The document holds great faith in natural "successional processes", recognizing that left to its own devices "pioneer" pine forests should eventually give way to a secondary forest which has far greater vegetative diversity.

Today, some three quarters of lands zoned as forests have already been planted. Yet, when new stands are established (or damaged stands replaced) increasingly areas are frequently planted as "khoresh" (Heb.: natural woodlands). The *Bible of Afforestation* states that 70% of the tree coverage on these lands should be "broad-leafed" species, such as oaks, terebinths, bay laurels (Laurus nobilis) and strawberry trees (*Arbutus andrachne)* (Osem et al., 2012, 16). In naturally regenerating forests, thinning directives are also designed to give priority to non-conifer, indigenous species. Pine trees are removed to allow for understory growth, enabling myriad other tree species to receive sufficient light to flourish (Osem, 2012, 29).

Existing pine plantations can also be enriched proactively. Research confirms that in *thinned* pine forests, oak trees can be recruited in a variety of fashions. For instance, acorn planting on such lands can yield a surprisingly high 4% survival rate, far greater than acorn success in unplanted batha open spaces or natural oak forests (Herr et al., 2011). When adult oak trees are threatened by construction projects, they are often transplanted into conifer monocultures at an expense of 25 to 400 dollars per tree (Herr et al., 2009).

The *Bible of Afforestation* also emphasizes the importance of supporting a complex understory, as true diversity in a forest is much more than simply an inventory of tree species, and should encompass the entire ecosystem that trees can support. In

areas that are earmarked as fuel breaks, clearly there is a competing priority that requires clearing of vegetation to reduce risk to adjacent communities. In short, the forests planted today do not resemble those of the past. Even in the southlands, where the low rainfall limits the potential of native trees, heroic efforts are made to include fruit trees and variety in semi-arid forests. More than just a new methodological approach, diversity in Israel's forests today can be seen as a fundamental strategy, if not an ideology.

CHEMICALS

Use of herbicides to suppress native shrubs and trees became a common practice in the JNF during the late 1950s as a means of both reducing competition with young saplings and reducing fire risks. Some of the chemicals utilized to this end were highly toxic. For instance, in 1960, the JNF began to use *simazine* to reduce weeds. The chemical is highly persistent and considered a probable carcinogen as it causes cancer in female mice. There were concerns that *simazine* would appear in the runoff from forests and accumulate in receiving streams. In order to control the pine processionary caterpillar, *endosulfan* and *diflubenzuron* were also pressed into service via aerial spraying (Mendel, 1987). This pesticide targets insects' nervous systems. Yet, collateral damage has been reported, including blindness in sheep, cows and pigs exposed while grazing in nearby land. Birds and fish are considered to be particularly vulnerable.

Since the 1960s JNF official publications express angst at the likely side effects of their pesticide program and the negative impact on "the biological equilibrium in woodlands" from the widespread chemical usage (Orni, 1969, 61). But pesticides were also convenient and it would take several decades until default spraying was curtailed.

By the 1990s, there was a shift to ground applications, where crews applied chemicals from back pack sprayers. Care was taken to ensure that native trees and vegetation did not come in contact with the chemicals (Bonneh, 2000). Once again, the forestry policy moved in stages towards sustainability. In 2005, following the European Union's decision to ban simazine, the JNF board's 'Sustainable Development" sub-committee decided to phase out use of the chemical in Israel's forests as well. Today, when other herbicides are required, they are limited to a more costly biodegradable, alternative.

On the issue of pesticides, the *Bible of Afforestation* states as a general policy: "Use of chemical pesticides should be minimized via spot spraying and use of alternative pest control techniques such as land covering…. and especially grazing" (Osem et al., 2012, 39). There are three cases where spraying is permitted: When chemicals are needed to reduce vegetation in fuel breaks and at road sides; for eradication of invasive species; and for reduction of pests, such as the pine processionary caterpil-

lar, which can constitute a human health hazard. But even then, spraying is considered as a last resort after other alternatives are considered and found impractical. Spraying is not to be repeated frequently in the same area, in order to prevent the buildup of resistance among pest populations. Only chemicals that are considered "environmentally friendly" are allowed and these must be applied in a highly selective, targeted fashion (Osem et al,, 2012, 41).

FOREST FIRES – PREVENTION AND RESTORATION

Unfortunately, fires are extremely common in Israeli forests. While the mega fires in the Carmel and during the Lebanon War have attracted international attention, on average, there are 500 to 1100 major conflagrations a year, occurring almost exclusively during the dry summer months. Over half of these are considered to be caused intentionally, as a result of nationalistically motivated arson by Israeli-Arab Palestinians (Bonneh et al., 2003). An elaborate system has been devised over the years to reduce the damage caused by these fires. This includes a network of fuel breaks, observation towers and monitoring. While there is no statutory requirement for them to do so, the foresters at the JNF are actively involved in fighting conflagrations and the organization has recently upgraded its fleet of 23 fire engines. In 2011, Israel's IDF air force created a special fire-fighting unit.

The *Bible of Afforestation* continues these general policies, and articulates several of the key changes which had already taken place in forest fire related policies. For instance, the foresters of the British Mandate blamed overgrazing for massive soil erosion and the decimation of young forest stands. Their policy response was essentially to declare war on the ubiquitous "black goats" and to ban grazing in forest reserves. Israel continued this perspective for several decades (Wachs and Tal, 2009). Based on their observations, however, ecologists began to argue that this was an ill-considered policy and that controlled grazing not only boosted biodiversity, but was actually a critical management tool for clearing flammable understory and reducing the risk of forest fires (Pervolotsky and Seligman, 1998). The *Forest Bible* embraces this position whole heartedly and contains an entire chapter entitled: "Principles for Managing Grazing in the Forest" (Osem et al., 2012, 34-35). The policy calls for site-specific plans that specify the types of animal and herd size appropriate for anticipated forest biomass and carrying capacity. In a major departure from previous policies, "prescribed burning" is also embraced as a future management option which needs to be better explored and utilized in the future (Osem et al., 2012,. 42).

But the most significant change involves post-fire planting strategies. In the past, replanting occurred automatically and as a matter of course following fires. New seedlings brought an existential sense of renewal and constituted a somewhat visceral therapy for the loss of trees. Ecologists, however, came to see this as bad idea that undermined the natural successional processes in forests where fires were a natural

occurrence. By the 1990s, this ecological perspective became de facto policy after major fires. Based on these successful trials, the *Bible of Afforestation* calls for reliance on natural processes of regeneration. Intervention immediately after fires is limited to removing the burnt woody debris that constitutes a safety hazard and exacerbates the potential for erosion on the bare lands. Removal of debris, however, should only take place after a full winter season has transpired to allow for maximal ground cover and reduced erosion conditions. Only after natural regeneration proves inadequate is planting allowed, and foresters are expected to wait at least two years after the fire before they begin. As pine seedlings frequently emerge in an astonishingly high density following fires, thinning these regrown stands should take place within two to seven years of the blaze (Osem et al., 2012, 54-55).

COMMUNITY INVOLVEMENT

During their first forty years, there was only modest utilization of Israel's forests for recreational purposes. Like other agricultural areas, the public did not particularly feel welcome; there were few access roads, picnic areas, playgrounds, etc. This situation slowly changed during the 1970s and 1980s until a formal decision was reached during the 1990s to "open the forests up to the public" (Shne'or, 2005). There were both tactical and strategic considerations behind this decision. Identification with the local woodlands swelled as the public took advantage of the forests. This support was deemed important for the JNF given its unique non-governmental status. Substantively, as Israel became a more urban and densely populated country, people's need for natural sanctuaries grew more acute. The forests provided an important component of many citizens' quality of life. Indeed, during the recent 2012 Passover holiday, 2 million Israelis (more than a quarter of the population) reportedly visited forests within Israel as part of their vacation activities.

The new policy requires considerable investment, not only in infrastructure (such as bike paths, restrooms, etc.), but also in ongoing operation maintenance. For instance, every year the JNF outsources the cleanup work after weekend picnickers and their massive quantities of litter at an expense of four million dollars. Many of the activities conducted in the forests, such as concerts, guided tours and festivals, frequently do not cover expenses. Fortunately, the JNF has access to such funds. The price of public access to well-managed forests should not be understimated.

The *Bible of Afforestation* sets forward a series of considerations in planning a strategy for hosting the public. Determining who the target audience is, the anticipated intensity of visits and other considerations is of course site-specific. While in the past, decisions about the formation of the forest were made by a small circle of foresters, the *Bible of Afforestation* calls for active public participation in planning and running these parks. The natural ecological assets, heritage sites and open spaces that need to be protected are to be identified and highlighted for visitors. To the ex-

tent possible, this process also includes assessing *appropriate* business opportunities that can be sold to local concessionaires (Osem et al., 2012, 61).

Basic management principles are to drive operational aspects of the community outreach program. Intensive human activities are concentrated into a single area, allowing most of the lands in a forest to be left undeveloped or utilized for "extensive" activities. This means that physical development (information centers, restaurants, etc.) should be relatively contiguous and that environmentally friendly construction is expected (Osem et al., 2012, 61-63). Each forest should have its own plan to ensure the smoothness of its operations. The plan should include specifications for the physical facilities (signs, roads, entrance ways, handicapped accessibility facilities) as well as a clear programmatic agenda for the people who come to visit.

The *Bible of Afforestation* contains dozens of other operational directives – from thinning schedules and rules for utilizing wood collecting during pruning to contingency plans for adapting to drought years. It is also not intended to be a static document and will surely be amended as the country's researchers push foresters up an ongoing learning curve. Yet, the general orientation remains consistent and reflects a commitment to producing forests that enrich the country's natural ecosystems and are a blessing to its people.

CONCLUSIONS – UNFINISHED BUSINESS

While the *Bible of Afforestation* reflects a dramatic shift towards more environmentally sensitive forestry, controversies remain. There is criticism regarding the legitimacy and the sustainability of the southernmost stands, planted in areas with minimal rainfall – less than 300 mm/year. Here forests are clearly not indigenous. Rather than reforestation, the JNF engages in afforestation and changes the natural landscape. Critics claim that the trees damage the natural biodiversity, usurping the scarce precipitation for forests that cannot regenerate naturally. These woodlands are based on *Mediterranean* vegetation, even as the climate is drier (Rothschild, 2011).

Defenders of present policies point to the fact that the lands on which the southern forests are planted are already highly degraded from human activities, with many areas showing soil loss of three meters and more. When the countryside has been overgrazed for millennia, there is little room for romantic and glorified notions of "wilderness". Trees have been planted in the Negev region for hundreds of years and the present forests are only an extension of this ancient heritage. Moreover, the new generation forests increasingly are designed to maximize diversity and provide disparate habitats.

It is difficult to argue with empirical findings that indicate that Israel's southern forests produce a rich range of ecosystem services: from carbon sequestration to erosion prevention (Safriel et al., 2010, Grunzweig, 2007). The debate is largely

an ethical and aesthetic one as to the appropriate role of humans in lands that are already highly damaged.

Israel's forestry program has surely made mistakes and needs to continuously strive to improve its performance. But it does provide an alternative model to the sad litany of deforestation, erosion, soil fertility loss, famine and human suffering which characterizes many other dryland countries, particularly in the developing world. The question is not whether these deforested lands need to be rehabilitated and planted, but what is the optimal ecological, economic and social approach to planting forests in drylands. Israel's new *Bible of Afforestation* offers an interim report from a sixty-year "trial and error" process that has pursued this objective with some success.

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