



Shifting Sands

Land and Water Management in the Middle East

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While the Middle East is frequently in the news because of political volatility and violence, there is an underlying lack of environmental equilibrium that poses a comparable threat to regional stability. Israel's neighbors – Egypt, Jordan, and Palestine – are arid countries with limited natural carrying capacity and burgeoning populations. Providing food and employment in what were traditionally agrarian economies has contributed to significant depletion of soil and water resources. Israel's experience as an innovator in technologically intensive dryland agriculture and forestry is entirely different. Yet it is not clear whether the grand Israeli experiment in water management and combating of desertification offers a compelling alternative model to its neighbors should diplomatic breakthroughs pave the way for transboundary cooperation. Not only are the socio-economic and cultural circumstances entirely different, but the sustainability of some of Israel's unique management practices remains questionable.

There was a time when the region was considered a break basket whose farmers produced crops beyond local

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demand. The natural ebb and flow of the Nile provided a steady supply of water and nutrients to Egyptian farmers. The Fellah – the Palestinian, Jordanian, and Syrian peasant – although taxed and exploited by colonial rulers for centuries, managed to produce food beyond subsistence levels. Yet decades of geometric population growth push today's farmers beyond past equilibriums with soil degradation and water quality contamination threatening the very sustenance of people across the region.

Food shortages in Egypt are manifested by a new culture of consumer hoarding, with long queues common-

place for basic staples like bread and vegetables. In the five years following 2007, the Food and Agriculture Organization of the United Nations reports that Egyptian cereal imports increased by 60 percent. Dwindling wheat stocks are front-page news stories, with remaining reserves now measured in days. Helpless to provide reasonable levels of commodities, the government began telling citizens to cope with malnutrition and hunger by not “overeating.”

Desertification in Jordan grows worse: Local ecosystems show signs of degradation, with chronic top soil loss and reduced vegetative cover threatening farmers’ liveli-

The problem is geometric demographic growth. In that respect, Israel is no different than its neighbors. In 1950, there were one million residents in the new state. By 1960, the number had doubled, and the increase continued steadily until reaching today’s population of eight million. During the same period, the number of Egyptians grew from 20 to over 80 million, Palestinian population tripled to over three million, and Jordan went from under of half a million to over six million citizens today. As water scarcity became more severe, efforts to produce food aggressively pushed marginal, erosive lands into cultivation.

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hoods. Direct drivers of Jordanian desertification include improper tillage, overgrazing, and mining ancient fossil groundwater.

Just over the border, Israel has taken a different path that ostensibly avoids many of these ecological pitfalls. After 65 years, the country can boast impressive statistics: at a time when farm productivity in many countries of the region is static or falling, official figures show that since its inception, Israel’s agricultural yields have increased eighteen-fold. In the early 1950s, a full-time agricultural worker supplied food for seventeen people; by 2010, that figure had risen to 113. Most remarkably, fresh water consumption has actually dropped during recent years due to genetically superior, drought and salt resistant plants, effluent reuse, and drip irrigation. The country consistently produces more “crop to the drop.”

Ecologically, Israel’s drylands are anomalous. After millennia of deforestation, overgrazing, and primitive farming practices, erosion was extensive and the natural woodlands that formed Biblical landscape were decimated. When Israel gained independence, less than 2 percent of the country’s lands were forested. Today, 260 million trees later, over 8 percent of the countryside is afforested; canopy cover should reach 10 percent before leveling off in twenty years. Palestine and Jordan also started the second half of the twentieth century with a denuded geography. But today, woodlands only cover 1.5 percent and 1.1 percent, of their countrysides respectively.

Unsustainable Trends

Yet all is not well in the Holy Land. In internal presentations, Israel’s Ministry of Agriculture acknowledges that if the accounting is done honestly, local farmers produce only 45 percent of the net calories consumed domestically. (Meat and bread production are based on grain imports.) Although a world innovator in irrigation and agricultural technologies, food security is as precarious as ever.

This situation is exacerbated by climate change. In the Middle East, global warming can no longer be dismissed as Al Gore’s gloomy prediction. Rather, it constitutes a new hydrological reality. Summer temperatures are significantly higher, raising aridity indexes and jeopardizing myriad crops. In Israel, recent studies show a significant decrease in annual precipitation in the Galilee, reducing spring flow in the Jordan River and lowering availability of water volume in the Kinneret Lake (the Sea of Galilee). The river was never “deep and wide” as the spiritual suggests – but its present puny and putrid flow constitutes a metaphor for the region’s general depletion. Groundwater has also suffered. Over 300 wells were recently decommissioned due to high concentrations of nitrates and excess salinity along with more toxic chemicals.

Managing for Dryland Sustainability

Israel’s strategies in water management, agriculture, and forestry are unique. They may offer hopeful alternatives for policymakers in nearby countries and for drylands around the world. A common strategy to protect soil and water resources may not only offer a blessing to Israel’s neighbors, but provide critical confidence building measures as the region’s leaders muddle towards political conciliation. Beyond environmental benefits, ecological cooperation can provide economic dividends for agriculture and tourism that can help change skeptical local perceptions about the dividends of peace.

Lessons learned in four components of Israel’s idiosyncratic strategy to address desertification are worth considering:

1. Wastewater Reuse

The transformation of large “barren” areas in Israel’s semi-arid regions into highly productive agricultural lands is largely a function recycling effluents. Some 82 percent of Israel’s sewage is recycled; other international leaders such

as Spain or Australia are still below 20 percent. Treated wastewater presently makes up half of the country's irrigation supply. It also solves the universal environmental conundrum of what to do with sewage effluents.

Yet a highly competent school of scientists has begun to challenge the sustainability of these practices. Evaporation ensures that effluents produced by even the most efficacious treatment technologies are saltier than fresh water. Salinity can damage plant growth in the short term. In the long term, sodium compounds in irrigation water can catalyze ion exchange in the clay fraction of soils, leaving it permanently damaged.

Drip irrigation, ubiquitous among Israeli farms, reduces these pernicious side effects, but may not be able to prevent them in the long run. Wastewater eventually creates surface crusts by clogging soils while stymieing aeration and seed sprouting. Add to that concerns about micro-contaminants, endocrine disrupting chemicals, and diseases that may pass from the soil into roots and stems. An economic analysis by leading Israeli water expert Professor Dan Zaslavsky suggests that when the environmental costs are fully calculated, a metric cube of wastewater can cost as much as two dollars more than the desalination production price.

Israeli irrigation researchers are starting to report unanticipated problems among perennial tree and fruit crops that are long-term recipients of recycled effluents. As rains are scarce, no natural washing mechanisms exist that can flush residual salts out of the soil and into the sea. The long term implications of maintaining salts are catastrophic for surrounding eco and agricultural systems. In many regions, their ultimate percolation into groundwater is a matter of time.

Does this mean that wastewater reuse should no

longer be part of a food security or anti-desertification strategy in other dryland nations? Probably not. Treated effluents can be a valuable source of water. But pitfalls must be avoided. The outcome of any serious cost-benefit equation will be based on a variety of assumptions, be they technological, hydrological or temporal. Ultimately, the one axiom to emerge from Israel's experience with wastewater is that without high level, tertiary treatment and near desalination levels of salt removal, it is best not to compromise very sensitive soils.

2. Desalination

Responding to several consecutive years of droughts, in 2002, Israel's cabinet approved the establishment of four desalination facilities on the Mediterranean coast that soon increased water supply by some 20 percent. Based on the smashing success of the first facilities, the project was expanded: by the end of 2014, five major plants built by sundry Israeli and international consortiums will be in full operation, providing 600 million cubic meters of water – more than 50 percent of the naturally available fresh water reserves. In the newly-built plants, water is produced at price of 55 cents per cubic meter. In other words, notwithstanding the rise in global energy prices, 100 liters of pure H₂O can be produced for roughly five cents. This “sea change” in water supply means that local streams that have long been deprived of their natural flow may once again gush with life. It means that farmers' water allocations, which have been highly erratic, will be far more predictable. It reduces the stress of successive drought years, creating a new level of certainty in water management macro-decisions. And it means that there is a far greater likelihood of resolving Israel's long-standing disagreements with Palestinians over the division of com-

mon hydrological resources. Turning water into an economic commodity that can be produced inexpensively helps diffuse the hydro-hysteria that has sabotaged natural resource negotiations in the region for so long.

For many Israeli environmentalists, the advent of desalination posed a philosophical conundrum. After years of preaching the gospel of sustainability, which assumes a “spaceship earth” model of finite resources, it suddenly seemed that there was enough water in the sea to provide households, industries, and even farmers with an endless supply. Yet there were justifiable concerns that desalination plants would come at the expense of scarce coastal lands. Moreover, the discharge of the



Two men walk in the world's largest reverse osmosis desalination plant in Hadera, north of Tel Aviv, during its inauguration in May 2010. Through facilities like these, Israel hopes to address the country's water shortage concerns.

brine and anti-scalant chemicals from the desalination plants could have had a negative impact on the receiving marine environment. Thus far, clever integration of facilities into existing beach-front infrastructure facilities such as electricity plants avoided meaningful coastal damage. Moreover, monitoring of outflows from the plants into the sea suggests that impacts from brine discharges are limited to a small circumference, and their effect actually may be beneficial to local fisheries.

Nonetheless, as long as the new desalination facilities rely on fossil fuels, they significantly increase local energy demand. In order to produce a cubic meter of water, 3.5 kilowatt hours of energy are required. Each time Israel adds a major new desalination plant, national electricity demand increases by one percent.

Thus, the paramount environmental lesson from Israel's desalination experience is that the link between energy and water resources is no longer incidental or coincidental. Countries that make strategic decisions to address water scarcity through desalination will see their electricity consumption take a quantum leap upward. During the past few years, lip-service to reducing greenhouse gas emissions has become the norm among Climate Change Convention signatories. But countries like Australia have shown that desalination need not solve one environmental problem by exacerbating another. Renewable energy facilities can and should accompany any significant shift to desalinated water. Carbon neutrality should not be just a slogan but an operational prerequisite for the next generation of desalination facilities.

Israel's experience suggests that cost-effective technologies exist to dramatically expand water resources in the region. The territorial seas of Gaza, Aqaba, and Egypt can provide water abundance. The desalination revolution offers these countries a new lease on food security, allowing them to deliver potable water to citizens at an affordable price.

3. Dryland Afforestation

After several decades of trial and error, dryland afforestation in Israel is receiving increasing international attention. Typically, silviculture projects are not considered viable in dryland regions when precipitation falls below 400 mm/year. Yet in Israel's Negev southlands, drought-resistant conifer forests flourish in arid climates of 280 mm annual rainfall while still providing significant ecosystem services. For instance, during flash floods in arid regions, tree canopies and root systems essentially eliminate runoff and soil erosion. But that is only the start of the story.

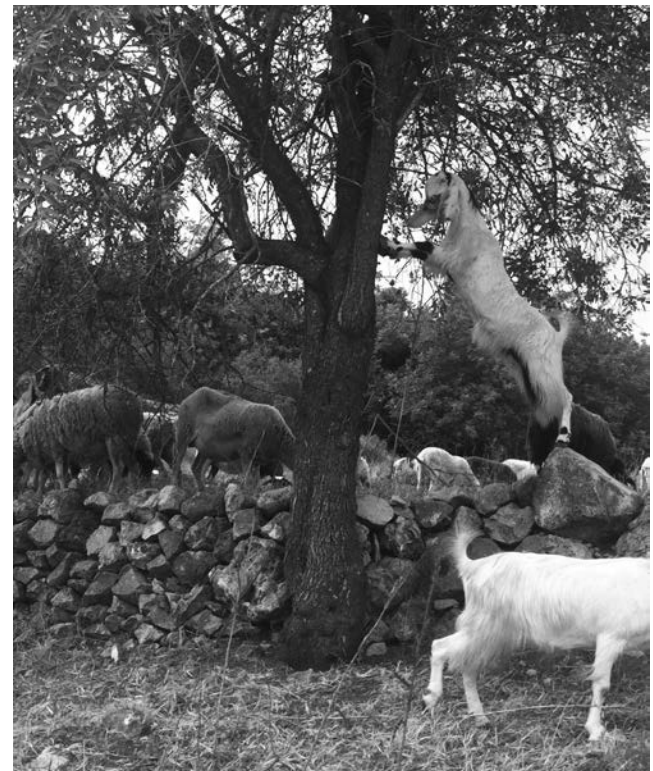
A monitoring station at Yatir forest – Israel's largest – reports that carbon sequestration levels in the pine trees are comparable to those of Europe's temperate forests. Moreover, during the forests' first thirty-five years, carbon concentrations in the underlying soil literally doubled. As the world considers strategies for reducing greenhouse gas concentrations, dryland afforestation can play an important role.

It is also notable that the Yatir forest is located on Israel's southern border with the West Bank. Palestinian lands on the other side of the fence remain denuded and degraded. There is no reason why a greenbelt linking the two countries could not be planted there to expand habitats and create contiguous woodlands to bring the two nations together. Many other such adjacent lands could benefit from peace parks.

4. Ecologically sustainable grazing

In a classic case of unregulated commons, millennia of overgrazing by nomadic herds led to vegetative cover loss and severe soil erosion across the country. Setting stock limits and rotation schedules not only ameliorated the negative impacts of pastoral animal husbandry, but made grazing a critical land management and fire suppression practice.

During the first half of the twentieth century, goats were singled out by British colonial foresters and agronomists as environmental enemy "number one". Israel's nascent soil conservation service shared this anti-grazing bias. Over the centuries, tremendous losses of soil (often over a meter in depth) had transformed fertile lands into deserts. The desertification process purportedly started with herds that exceeded rangeland carrying capacity. The removal of vegetative cover exposed soils to ferocious winter rain events or dust storms. With nothing to hold the good earth down, the land hemorrhaged its soils. Goats are the most aggressive of the domesticated foragers, so



Goats graze in a forest in Israel's Judean Hills in July of 2013. Well-managed grazing has, unexpectedly, become a critical tool for foresters.

they were singled out for opprobrium. But this zoological prejudice was soon to be challenged.

Local ecologists began to question the conventional wisdom after research showed that well-managed grazing regimes could be salubrious for soils. The new consensus holds that regulated grazing may actually be essential, providing a range of benefits. According to ecological theories of “intermittent disturbance,” if they do not overstay their welcome, grazing animals prevent ecosystems from drifting into a lower level of biodiversity where dominating plants crowd out more sensitive species. Grazing soon became a critical management tool for foresters. One of the reasons why Israel’s 2010 Carmel forest fire was the worst in the region’s recorded history is that intense seasonal grazing had not been maintained. The surviving forest understory served as fuel, and flames raged out of control.

which reflect first versus third world dynamics. While Israelis may be concerned about monitoring pharmaceutical residues in ground water, Jordanians and Palestinians still grapple with irregular water supply, with taps only running two to three times a week in major cities. Before reaching optimal treatment levels for wastewater reuse, first basic infrastructure needs to be built. For instance, over 90 percent of Palestinian sewage still goes untreated.

So there are more than merely psychological barriers that need to be overcome. Yet, the possibility of a renewed round of peace talks brings environmental opportunities. River rehabilitation, ecological restoration and reforestation all should be tackled at a regional level. As the EU and the US consider ways to bring the sides to the table, investing in environmental infrastructure holds the promise of improving quality of life and creating a shared stake

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Unregulated grazing is indeed a scourge and remains a major driver of desertification. It is the reason why aerial photos show Israel’s geographic borders as clearly demarcated botanical contrasts. Israeli rangelands literally appear green alongside the bare and eroded territory of Lebanon and Egypt where grazing continues unchecked. The lesson for public policy is clear: foraging animals have been part of symbiotic relationships between humans and the land from time immemorial and can continue to be so, if they are controlled in a scientifically validated, sustainable program.

Conclusion

Israel’s experience in land and water management in its drylands offers a distinctive model that might be very valuable to other countries facing dwindling water resources and desertified lands. There are several caveats, however, that need to be considered by decision-makers.

Sharing technological innovations in land and water management might appear to be a natural part of a reconciliation process. In fact, past efforts have been impeded by suspicion and enmity. For example, some Jordanians have expressed fear of agronomic hegemony: when Israel began exporting potatoes to Jordan, there was a hue and cry that the superior products constituted unfair competition. Palestinians refused to receive water from a desalination plant in Hadera that would have doubled their water supply, claiming it smacked of neo-colonial domination. Israelis today enjoy this copious water source while Palestinian per capita water levels are lower than ever.

Part of the problem involves considerable objective gaps in capacity that exist between Israel and its neighbors,

in reconciliation.

Secondly, policy analysis distinguishes between direct and the indirect drivers of desertification processes. Policy interventions and technological innovations tend to target direct drivers, initially meeting some success. Stock limits do abate overgrazing; contour plowing and terracing can reduce erosive soil loss; more robust species improve yields; alternative fuels reduce pressure on trees and allow for reestablishment of woodlands; desalination supplements depleted water resources. But ultimately, these efforts address symptoms. Decision makers need to recognize that the dramatic population growth is sabotaging their countries’ aspirations for a sustainable future, pushing lands and ecosystems beyond their carrying capacity. Without policies that address the indirect drivers that produce unsustainable dynamics, progress will be elusive.

Finally, a tablespoon of humility is critical when considering the merits of Israeli innovations in silviculture, agriculture or water management. The precautionary principle offers a good point of departure. For centuries, the Fertile Crescent was home to flourishing and sophisticated agrarian societies. Yet, one fine day a threshold was crossed: years of flood irrigation left behind tiny (and seemingly trivial) quantities of salt that slowly moved fecund soils into a different, salinized state. Basic rules of botany and soil science began to weigh in – and soon, an entire civilization had to abandon its land and way of life. When considering historical “collapses” it is best to remember that while Israeli technology has done an astonishingly good job of overcoming many traditional obstacles to dryland cultivation, the experiment is still in its early stages. The jury is still out. ■