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Role of museums and botanical gardens in ecosystem services in developing countries: case study and outlook

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ABSTRACT

Unprecedented environmental challenges require new tools. Knowledge based on scientific research is critical for the creation of environmental awareness and education in order to bring about behavioural changes in society at large. Well-structured museums and botanical gardens in developing countries can play significant roles in research, education, and conservation even when governmental institutions are weak and underfunded. The paper offers a case study of the nascent Palestine Institute of Sustainability and Palestine Museum of Natural History with a botanical garden. The related SWOT (strengths, weaknesses, opportunities, and threats) analysis concludes that, despite some limitations and challenges, this is a successful model that should be replicated in other impoverished communities.

KEYWORDS

Palestine; environment; ecosystem; development

Introduction

Scientists have estimated that there are 8.7 million total species of eukaryotic organisms on earth, yet have only classified around 1.8 million [1]. Many species have gone extinct before their classification and many more are destined to follow this trend. Natural history, the discipline concerned with classification of species, is fundamental to human society in myriad areas including human health, food security, environmental protection, tourism, and economic development [2]. The globally recognised Convention on Biological Diversity, adopted at the 1992 Earth Summit in Rio de Janeiro, Brazil, highlighted three key principles: conservation of biological diversity, sustainable use of nature, and fair and equitable sharing of the benefits. Economics and social development are two key factors that determine the success of these principles. Economically, a nation's GDP is directly correlated with its emphasis on environmental awareness [3]. That is why there is an increased emphasis globally on the economics of biodiversity protection and what has become known as ecosystem service [4].

Environmental consciousness and conservation is affected not only by poverty, but also by the nation's governance structure and stage of development [5]. Many countries have faced

an anti-colonial struggle that has compounded environmental challenges and produced weak corrupt governments even in a post-colonial structure. Politics and social factors in developing countries, exemplified by the current situation in Palestine, play a significant role in determining engagement with environmental issues [6]. The task of economic improvement under occupation often dwarfs crucial environmental initiatives in Palestine [7]. Environmentalists in developing countries especially those in politically difficult circumstances are seeking to optimise current methods and develop new techniques for using limited resources to protect their particularly fragile environments.

Natural history museums are integral to both sustainable economic development and to the promotion of science, culture, education, and natural and historical conservation [8–14]. Museums have evolved to be symbols of national identity [15,16]. These institutions are critical for biodiversity research and conservation that addresses pressing modern concerns including overpopulation, political instability, and climate change [17–19]. Similar to natural history museums, botanical gardens' conservation of flora can inspire behavioural change for local and international visitors [20–23]. Botanical gardens also create greater diversity of green spaces within urban environments [24] and are important for biological conservation [25]. These spaces and associated herbaria provide practical applied research with direct benefits for society, ranging from knowledge of medicinal plants [26] to knowledge of climate change [24]. Ecosystem services and human sustainability both profit from the creation of gardens [25,27,28] especially in urban settings [29]. Developing countries clearly lack both museums and botanical gardens compared to developed countries [27]. More discussion of the relevance of these facilities in developing countries is urgently needed.

In this report, we discuss the experiences of the first natural history museum and botanical garden in the Palestinian territories created in response to challenges of human development and environmental sustainability in difficult circumstances. We discuss the lessons learned while implementing this project, realised largely by volunteer and student efforts, with very limited resources as a potential model to apply in other developing countries.

Case study

Palestine is located in Western Asia at the juncture of Asia, Africa, and Europe and is impacted by the Great Rift Valley between the African and Arabian continental plates. This geography and geologic history contributed to the creation of the Fertile Crescent and the first domestication of plants and animals [30]. Despite its small geographic size, Palestine's location and topography has ensured significant biodiversity and a rich history of fauna and flora, including human history. For example, hundreds of millions of birds pass through Palestine in annual migration between Africa and Europe. Species including rhinoceros, hippopotamus, spotted hyenas, and even elephants were extirpated largely because of human activities from ancient time to present [31]. The scale of environmental destruction and deforestation has increased significantly in the past 200 years. In the past 130 years the Zionist/Palestinian conflict resulted in several wars and significant population dislocation [32]. The environment and the physical landscape became additional victims of this conflict [33–36].

The development of natural history museums and botanical gardens in a nascent state like Palestine is an intriguing case study. The occupied Palestinian territories (OPT, occupied by Israel since 1967) are expected to become an independent state of Palestine according to

the consensus of the international community. Emerging from decades of de-development in the context of occupation [37] produces the unique challenges shared by other developing countries in post-colonial eras. One major challenge in conditions of deprivation and poverty is sustainable economic development and protection of the environment. Wealthy countries not only produce significant research but are more likely to use their research to change society [3]. The status of research and development (R&D) in the OPT is very poor and misdirected; we need much more research especially on health, agriculture, and the environment [38].

Natural protection initiatives are often secondary to narrow and short-term political interests of governments in the region. Serious environmental challenges require new modes of thinking by which decision makers can identify new social priorities. Our initial scoping studies included a number of stakeholders and concluded that the most obvious *first* step is to enhance and consequently direct the scarcer research capacities and resources to areas such as sustainable agriculture and the environment [38]. *Secondly*, education must be restructured to emphasise conservation issues (we suggest nothing short of an educational revolution) [7]. *Finally*, there must be beneficial outcomes and an understanding of potential economic benefits of both environmental conservation efforts and biodiversity conservation in Palestine as elsewhere (ecosystem services/value) [39,40]. In Palestine, as elsewhere, there is an interest in the national importance of ethnobotany and ethnozoology [41–44]. The importance of these fields is clear in the case of many developing countries, but the decades-old struggle in Palestine adds a distinct challenge. An obvious response to these difficulties is the development of institutions that engage in research, education, and conservation with local knowledge and local solutions (situational analysis).

National institutions of the Palestinian authority, heavily dependent on foreign aid, are vulnerable and unstable. The struggling state is incapable of prioritising issues such as biodiversity, conservation, and sustainable development. We must ask ourselves: can we afford to defer considering issues of biodiversity and sustainable development until we end the occupation and gain freedom and independence? A group of concerned citizens with varying capacities (financial, educational, knowledge) banded together to create the Palestine Museum of Natural History (PMNH) and its Palestine Institute of Biodiversity and Sustainability (PIBS) at Bethlehem University. The first meeting of volunteers (9 July 2014) agreed to the following statement of **Mission**: to work to research, educate about, and conserve our natural world, culture and heritage and use knowledge to promote responsible human interactions with our environment. The agreed **Goals**:

- (1) Explore the diversity of the fauna, flora, and human ethnography via collections and scientific research that includes morphology and genetics.
- (2) Environmental protection and responsible interaction between people and the environment.
- (3) Use the knowledge gained from books, databases, and collections to promote science education.
- (4) Develop and increase respect: (a) for ourselves (self-empowerment), (b) for our fellow human beings (regardless of background), and (c) for all living creatures and our shared earth.
- (5) Use research results in areas like history, culture, permaculture, and biological control to nurture sustainable communities.

One subsidiary, but significant, objective of the current project is to begin to fulfil the obligations of Palestine under international treaties even before we receive full independence. Conventions include the Convention on Biological Diversity (CBD), the Nagoya Protocol on Access and Benefit-Sharing (ABS), the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES).

During the first year of the Museum's operation, we depended on initial local donations and volunteer efforts. In the second year, we received grants for projects including school environmental education and composting. The museum and its associated botanical garden, despite very limited resources (annual budget from donations and some contracts) and reliance on volunteer efforts, has accomplished much since its creation two years ago. Major accomplishments include:

- (i) Published two dozen papers in areas ranging from taxonomic studies to biodiversity to environmental pollution to museology [45].
- (ii) Held workshops and other educational events that benefitted over 3000 individuals.
- (iii) Developed webpage (palestinenature.org) and social media accounts and reached out via the internet to tens of thousands of people.
- (iv) Established mobile conservation projects in remote and underprivileged communities.
- (v) Improved science education at both school and university level benefitting hundreds of students via hands-on workshops and creation of environmental clubs.
- (vi) Developed an environmental impact assessment (EIA) unit and contributed to a management plan for the first OPT protected area.
- (vii) Provided consultancy services to the nascent Palestinian governmental agencies (e.g. Ministry of Health, Environmental Quality Authority, Ministry of Tourism, and Ministry of Agriculture).
- (viii) Transformed a neglected 12 dunum area (10 dunums = 1 hectare) into a nascent botanical garden and permaculture facility (including bee-keeping, aquaponics, and aquaculture). This site was and is used to develop ideas which are now being transferred to farmers and other members of the community (e.g. green walls and composting).

There is a short video about these activities [46].

SWOT analysis

PMNH/PIBS has a team of several museum employees, many volunteers, and a board comprising mainly Bethlehem University (BU) officials (Deans, Department Heads and key faculty) with other members from relevant segments of our society. This team worked diligently to analyse the museum situation and generate a strategy. Below is a SWOT analysis two years after our foundation which can be applied for similar institutions in developing countries.

Strengths

- (1) University setting with strong educational and research abilities and experiences (e.g. used human resources to develop educational modules for environmental awareness of students).
- (2) Physical infrastructure developed on site including rooms and a garden.
- (3) Laboratories available at the university and used in museum work and other infrastructure developed: photo library, PDF file library, print collection.
- (4) Good cooperation with NGOs and governmental officials (particularly Environmental Quality Authority and Ministries of Agriculture and Health).
- (5) Developed support network which brings donations, contributions in kind, and volunteers (internet and staff connections helpful).
- (6) Existing educational programs at Bethlehem and other Palestinian universities, such as Masters in Biotechnology, Environmental Studies, Tourism, Peacemaking, and advanced undergraduate programs, that provide a cadre of interested students.
- (7) A reputation for accuracy, integrity, and transparency came about because of the volunteerism and self-reliance.
- (8) Multicultural and multi-religious community of volunteers.
- (9) Collection and knowledge acquired through over 150 field trips in the past two years.
- (10) Utility of many websites/portals to recruit global volunteers (e.g. workaway).

Weaknesses

- (1) Social structure and history of oppression diminishes spirit of volunteerism.
- (2) Weak cooperation by some stakeholders (NGOs, government officials, others).
- (3) Space and funding not in line with our growth potential.
- (4) Limitations on human capital (need more qualified/trained, motivated people).
- (5) Weak publicity/media work that supports our mission and goals.
- (6) Occupation/colonisation places restrictions (e.g. freedom of movement, importation of material, and the focus on politics/security instead of environment and education).
- (7) New staff with limited experiences.
- (8) The one tiny exhibit hall and the garden of twelve dunums (10 dunums = 1 hectare), primarily used for permaculture research and education facilities, are relatively small to accommodate large number of visitors (currently we can only accommodate 50 at a time).

Opportunities

- (1) Mobilise available networks especially using the internet.
- (2) High potential for many research projects in an area little explored.
- (3) Better use of available funding agencies (private, public, individual, local, and international).
- (4) Partnership of further schools and institutions.
- (5) Potential enhanced leadership in environmental conservation.
- (6) Development of permaculture (including aquaculture and aquaponics) and recycling/upcycling then transfer of knowledge.

- (7) There are many opportunities to shape Palestinian sustainable development.

Threats

- (1) Individuals and other institutions who feel threatened by our success (e.g. assuming that funders may stop funding them).
- (2) Imbalance: potential for too many projects with few resources and individuals or hiring more people then running out of money.
- (3) Miscommunication internally and externally.
- (4) Politics: Palestinian internal politics and the Israeli occupation politics.
- (5) Failure of human resource (HR) management.

Our five year plan (2017–2021), considering this SWOT analysis of the first two years, includes:

- (1) Build a Palestine Institute of Biodiversity and Sustainability to offer training courses, diplomas, and even higher degrees.
- (2) Raise enough financial resources to ensure sustainability (infrastructure and operations).
- (3) Research: (a) To complete and publish 30 research projects in diverse areas (from agriculture to fauna to flora to environmental impact to genetics), (b) To have functional research units such as cytogenetics, entomology, and herpetology.
- (4) Human Resources (HR) and administration: (a) develop staff and have by end of five years three full time researchers, an administrative director, a project manager, an education specialist, two garden workers, an IT person, a publicity/media person, and a secretary/guide, (b) to have at least 200 committed volunteers willing to help the museum (local and international), (c) seamless internal operation and an oversight board of people who actually help the museum have administrative sustainability, (d) By end of five years, have revenues exceed or at least cover all expenses (financial sustainability).
- (5) Garden: To develop medicinal, herbal, composting, and other permaculture sections.
- (6) Education: (a) To develop seven indoor exhibits and seven outdoor exhibits (all interactive) (b) To do minimum of six workshops each year in diverse areas, for the five years a total of more than 30 workshops, (c) to host a minimum 10,000 students over the five year period.
- (7) Conservation: (a) Study three protected areas with same level of intensity as done for Wadi Quff (six publications), (b) Develop a team of citizens (focusing on youth) for environmental conservation.
- (8) Publicity and Media Work: (a) Every week we need to have at least one media appearance (newspapers, TV, radio etc.), (b) have a functioning ‘friends of’ groups in many countries and cities that help fundraise and bring other support like networking etc., (c) museum website and social media activities integrated with the university’s other publicity initiatives, (d) expand roster of museum brochures and videos focused on students.

Discussion

The success of our case study articulated above, despite the challenges it faced and continues to face, may be explained by several factors. *First*, we emphasised a grassroots bottom-up approach rather than a top-down approach. Volunteers (including the volunteer museum leadership) were encouraged to take and implement decisions and given significant freedom to do so from the university administration. *Second*, we emphasised a focus on research, then education, and finally conservation in that order. This is because we cannot educate or conserve what we know little about. But research also opens up new opportunities (e.g. research in biology leads to research in agriculture or even to the urgent study of desertification and decline in biodiversity). *Third*, there was and continues to be a huge need for the services offered by the museum and botanical garden which increasingly became a focal oasis for the society even under the very difficult political situation. More and more people became interested and talk to others, so that people locally and globally began to come to us without any publicity.

When the project was started in late 2014, the projections were modest, but they have so far been exceeded. The pause at two years to undertake a SWOT analysis and revitalise our efforts is not an issue of time only (2 years) but rather an issue of reflecting on available resources and accomplishments. One challenge now is to remain focused on our mission and goals and not to be distracted by side issues. Research must remain integral. The potential use of collections for environmental and biological research is significant [47]. Our collections in Palestine were used before and after launching the museum to evaluate loss of biodiversity in the Bethlehem region [33,34,36,48]. Collections were also used for studies of taxonomy including of mammals [33], scorpions [49,50], butterflies [51], grasshoppers and locusts [52], freshwater snails [53], amphibians [54], and reptiles [55]. We also did research on health impact of environmental pollutants using our existing limited resources [56,57]. These data are critical for education and conservation issues. We should continue to work in those areas and add areas of research like best methods for early education for environmental awareness, geology, ethnobotany and ethnozoology, ecosystem valuations, and environmental-socio-cultural interactions.

Beyond research, citizen awareness is a key to bringing about a social change for sustainable futures. Connections between science and individual experiences catalyse change in social behaviour regarding environmental protection and this is the essence of effective environmental education [58,59]. Open educational institutions, like museums and botanical gardens, help cultivate an informed and active citizenry, concerned to protect and value cultural and natural heritage [60]. Museums and botanical gardens should abandon outdated nineteenth century models of 'exhibits' [61]. There are, of course, some distinctions in successful design. Studies of normative guided tours by natural history museum staff identify high visitor satisfaction but low long-term behavioural or educational effect on students [62]. Visitors to botanical gardens tend to be less motivated by environmental issues than visitors to other free choice learning centres such as museums of natural history, zoos, aquariums, and natural areas [23]. Our combination of interactive museum experience, botanical garden, and permaculture facility removes these weaknesses and gives the visitor both a positive memorable experience and an outcome of behavioural change. This is evident from some preliminary studies of our visitors which showed high levels of satisfaction coupled with real commitments for change. For example, several student-led

initiatives at area schools have already occurred, including environmental clubs and developing school gardens.

Natural history collections can be more effectively used to expand their role in environmental conservation [63]. PMNH/PIBS aspires not only to teach appreciation of the value of scientific collections, but to change individual behaviours in favour of environmental conservation and sustainable societies. This may be difficult, but our initial structure rooted in grassroots actions and volunteerism has ensured a broad base of support to create the change we desire. PMNH/PIBS affiliation with an institute of higher education is beneficial for the creation of essential connections, and contribution to further quality education [64,65].

Establishing an integrated natural history museum and botanical garden (including a permaculture facility) in a developing country, especially within the context of occupation and colonisation, is complicated work. Our experience, summarised in the SWOT analysis above, can provide a model for others. Our focus on ecosystem services may be especially pertinent for similar organisations. We have accomplished much in a very short period of time. We will do even better when we move out of the cramped few rooms (that originally served as part of a student dormitory) and have a green building that is now the trend in museums [66,67]. Upon accomplishing all this, we will be equipped to delve deeper into the conservation component of our mission.

We have already begun to develop a network of people interested in environmental conservation both inside and outside Palestine. This network has reached 10,000 individuals. Our next task is to mobilise these citizens to change society in positive directions. Previous emphasis on species management in environmental protection has been replaced by ecosystem-based management or ecosystem approaches. Ecosystem approaches are now 'applied in ecology, human ecology, environmental planning, anthropology, psychology, and other disciplines [and] may provide a more trans-disciplinary route to successful integration of environment and development' [68]. In small developing countries with limited resources, trans-boundary conservation area (TBCA) approaches will be crucial [69].

Our project is cooperating with nearby states towards environmental conservation (for now mainly Jordan but this will expand). Our work is done with the cooperation of local and international universities, non-governmental organisations, and governments. For example, aided by funding from the UN Development Project (UNDP) we completed a faunal and floral survey of the first protected area to be administered by the Palestinian authority. Our work culminated in the development of an official management plan [70]. Our experiences, modest as they are, provide hope to others in developing countries, even those in conflict zones, that much can be achieved with good will and collaborative volunteer efforts.

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