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Review

Botanic Gardens Resources: Tangible and Intangible Aspects of Linking Biodiversity and Human Well-Being

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SUMMARY

Gardens are associated with sense of peace and a peaceful life. They have been always recognized as tangible resources for the improvement of humans. Botanic gardens (BGs) are innovative institutions that can help local people in many ways via the introduction of new economically valuable plant species, a creation of friendly and secure environment, an improvement and beautification of settlements, a city greening, a restoration and a repatriation of rare plants, the "horticultural therapy," a continuous education and public awareness, etc. Networks of about 2200 world botanic gardens in

153 countries play an important ecological role in conservation and mobilization of plant genetic resources for the regional, national and international development. BGs have a special environmental, scientific, cultural, aesthetic, and recreational importance. The numbers of botanic gardens in different regions are positively correlated with their countries human development indexes (HDI). This review emphasizes the fact that intangible aspects of BGs are as important as their tangible resources and they can not be discriminated in relation to human well-being. Both tangible (material) and intangible (not-material) resources of BGs are equally valuable for the sustainable development and linking biodiversity with public education, secure environment, nutrition, healthcare, poverty alleviation, socio-ecological and economical benefits for communities, including commercialization.

1. Introduction

"Keep a green tree in your heart and, perhaps, the singing birds will come"
Old Chinese saying

"The destiny of a part is a function of its position in the entire body"
M. Driesh, German Cytologist

Vegetable, fruit, and flower gardens are always associated with the sense of peace and peaceful life. The gardening is one of the most peaceful businesses in the world. It is possible that people collecting and raising plants were the most peaceful group in a community unlike hunters who used their weapons not only for hunting animals but also against humans. In human evolution gardens were crucial factors for the survival of communities, a source of food and medicinal herbs, shelter and clothing (Fig.1). Many nations have developed special spiritually valuable gardens such as, for instance, the Japanese gardens, the English walled gardens, etc. Botanic gardens of the world were developed mostly as a result of strong demand from the public and from very influential people interested in exotic, medicinal and beautiful plants collected from remote regions and countries. They made important contributions in the understanding how the mankind benefits from plants and from biodiversity. Currently **botanic gardens** (and arboreta) are defined as "**botanic institutions holding documented collections of living plants for purpose of scientific research, conservation, display and education**" (Wyse Jackson, 1999). Actual interests of governmental authorities and public in the role of botanic gardens in communities are connected with two main reasons: a problem of conservation and use of biodiversity for the purposes of sustainable development (Convention on Biodiversity, 1992), ecological education and enlightenment of the society. Human activities keep many nations out of poverty but at the price of loss of biodiversity in certain countries, not necessarily located in the same regions. Therefore a loss of biodiversity is considered to be a major threat for human developmental goals and for the progress of next generations. In this context BGs follow many international policies and conventions related to biodiversity conservation and improvement of human well-being such as Millennium Development Goals (MDGs), The Convention on Biological Diversity (CBD), Agenda 21 - Programme of Action for Sustainable Development, Global Strategy for Plant Conservation (GSPC),

The Convention Concerning the Protection of World Cultural and Natural Heritage, 1972 (World Heritage Convention), Millennium Ecosystem Assessment (MA), U.N. Convention to Combat Desertification, Ramsar Convention on Wetlands, International Agenda for Botanic Gardens in Conservation (IABGC). On the inter-regional and national levels there are specific rules and policies applicable for relations of BGs and countries in access to biodiversity and on benefit-sharing raised from economical use of plants and their derivatives. At country level, for instance, in Russia there are some federal laws applicable for BGs and concerning the biodiversity and protected areas/lands such as the Law on Natural Environment Protection (1991), the Law on Lake Baikal protection (2003), the Law on Strictly Protected Natural Territories (1995) as well as a regional legislation such as the Law of Irkutsk Oblast on Ecological Education and Formation of Ecological Culture (2004), and the Law on Strictly Protected Territories. Current biodiversity related policies, conventions and laws applicable to BGs usually regulate relations concerning such tangible resources as land and plant materials but intangible aspects are not considered as priorities or even not taken seriously. Only recently heads of five biodiversity related conventions came to the conclusion that "Biodiversity can indeed help alleviate hunger and poverty, can promote human health, and be the basis for ensuring freedom and equity for all" (in September, 2005). As a result, the world largest international plant conservation network, the Botanic Gardens Conservation International (BGCI), based in the United Kingdom, started a worldwide project review of the role of BGs in linking biodiversity with four selected aspects of human-well-being: nutrition, healthcare, poverty alleviation, community welfare (Waylen, 2006) (www. bgci.org/wellbeing).

Fig. 1 The classical paradigm of Botanic Gardens as an interface between nature and people. Introduction of economically valuable plants (edible, medicinal, ornamental and others) provides resources for the survival and improvement of human well-being

So, the main objective of this review was to analyze some aspects of botanic gardens resources (tangible and intangible) affecting human well-being and a possible impact of botanic gardens on communities.

2. Functions of Botanic Gardens in Relation to Biodiversity and Human Well-being

The list of the main directions and functions of BGs activities is extremely wide (Table 1) and it includes, alongside with scientific studies, all possible measures on the organization of rational and sustainable use of plant resources as outlined in the International Agenda for Botanic Gardens in Conservation (2000).

Each BG, based on its available resources and public demand, identifies the strategy and directions of development of scientific and educational projects (Leadlay, Greene, 1998), and also identifies its socio-ecological role and positioning in the region. The existing diversity of world BGs according to their different characteristics, structures, functions and ownership is extremely striking. It is impossible to find any identical botanic garden even within the same country. Obviously, a pattern of characteristics of BGs depends on their climatic conditions, socio-economical environment, history, ethno-cultural traditions and a location. This determines the uniqueness of each botanic garden and its regional role as a complex ecologically valuable resource. Therefore, the resulting impact of any botanic garden on the society and on the environment is a function of its position within the ministry, municipality, corporation or charity as well as existing links with the public.

Table 1. Main activities of botanic gardens (from the International Agenda for Botanic Gardens in Conservation, 2000).

Biodiversity conservation and related studies	Development of scientific basis for the rational use of plant resources	Education and public awareness promotion
1. Studies on biology of introduced plants in culture 2. Establishment of gene banks of indigenous plants, including seed banks and plant tissue cultures 3. Development of herbaria and research on plant systematic 4. Reintroduction of plant species back to nature and research on restoration of their natural habitats 5. Monitoring and assessment studies of the environmental pollution influence on vegetation and plants 6. Scientific studies of indigenous plants, conservation and restoration of rare and endangered species 7. Involvement of local community in environmental conservation and decision making on plant protection	1. Cultivation of diverse plant collection 2. Research on ethnobotany and traditional use of plants 3. Research on horticulture and gardening 4. Integrated pest and disease management (IPM) 5. Laboratory research, including plant propagation in vitro (tissue culture) 6. Evaluation and introduction of new genetic resources of edible plants in culture 7. Ornamental horticulture and floriculture 8. Cultivation, propagation and conservation of cultivars, including ancient ones (forms, varieties, etc.) 9. City planning and greening, land use	1. Environmental educational programs 2. Professional development, internship in botany, horticulture, and ecology 3. Public libraries and information centers 4. Facilities for recreation and rehabilitation 5. Teacher training (training of trainers) 6. Promotion of ecological tourism 7. Publication of special and scientific popular literature 8. Consulting for visitors 9. Distance learning 10. Involvement of mass media in public awareness promotion

Usually public demands and needs addressed from the local community towards the BG's resources and staffs are much wider and more complex than the rather narrow remit of the BG's supervising institution (university, governmental company, academy, etc.). In some cases this can cause hidden conflicts between the availability of instant

BG's resources being used for narrow institutional tasks with the possibility of their more efficient use in meeting public needs. In those places with well developed links between a BG and a public, where community has a certain influence or a partial public control over the BG's resources, the communities help the BGs to flourish and to develop their resources quite efficiently and sustainably. Harmonization of the BGs' policies and scientific traditions with needs of local communities is a task of keeping a balance in changing world. Such challenge and controversy between the inward and outward orientations of BGs is a main cause of possible divergence of development for many BGs which determines their further progress and positioning within the society and within the country. It demonstrates a dualism of BG roles.

Traditionally, botanical gardens in Russia (and ex-USSR) were considered as the organizations to carrying out pretty narrow utilitarian problems of certain departments (the Academy of Sciences, the Ministry of Education or municipality). However, according to ongoing trends, many botanic gardens of the world with upgraded resources and new technologies gradually began to grow out of departmental limits/frameworks to become important elements of a national natural and cultural heritage. From the late 20th century the role of BGs resources has begun to grow due to their involvement in developments in economic botany, home gardening and an agriculture, rational use of biodiversity, improvement of habitats/environment and environmental education for local people (Fig.2).

For instance, the Botanic Garden of Irkutsk State University is the only botanic garden in the whole region of Baikalian Siberia (see Fig. 5) and it holds a collection of about 3000 species and varieties of plants, representing the flora of Baikal region and different biomes of the world (Kuzevanov, Sizykh, 2005). The special attention is given to introduction and cultivation of tolerant and productive plants capable to survive and grow well and sustainably in the severe climate in Siberia. Such policy includes special measures for accumulation and propagation of rare and endangered species of regional flora. At present, the Garden holds about 100 rare plant species from the Lake Baikal region (World Natural Heritage Site). These cultivated plants are considered to be "living" gene bank of rare species becoming extinct in their natural habitats. Many of indigenous Siberian plants of edible and medicinal importance already have an actual or prospective value for the purposes of nutrition, healthcare, environmental monitoring

and environmental restoration (Kuzevanov et al., 2002).

Fig. 2. Botanic Gardens in Action. A) Field studies of indigenous plants, including botanical surveys, plant collecting, ecological monitoring, and environmental restoration in the Lake Baikal region. B) Educational courses in botany and ecology for university students and school children. C) Practical training in horticulture and gardening for students. D) The Horticultural Therapy program for social adaptation and correction of the social behavior of children with special needs, including disabled, orphaned children and kids at risk with criminal history (murder, robbery, etc.). (Photos from the archive of Botanic Garden of Irkutsk State University)

Traditionally in the Baikalian Siberia more than 80% of edible plants for consumption (staple food plants) come from home gardens where people grow vegetables, fruit trees, and herbs in dachas (plots of land for gardening attached to summer houses) outside of the city limits. It is life style and family traditions which people kept for generations which provided resource of tangibles and intangibles benefits necessary for survival and recreation in a frontier environment. Home

gardening provides a certain feeling of togetherness for extended families and their neighbors, which has an intangible value for the community welfare and peace keeping. So, in this context, the BGs play an important role in introduction of new resistant and tolerant forms of edible and ornamental plants for the improvement of home gardens, for improvement of traditions and technologies of home gardening. For years BGs in different countries were popular sources of fruit and ornamental trees for local communities. For example, such innovations as new varieties and forms of frost-tolerant seedlings of apricot trees (Fig.3, A) were selected and propagated at the BG of Irkutsk State University, and are now available for Siberians and are very popular (Eremeeva, 1999). For instance, a few new forms of a wild almond *Amygdalus pedunculata*, a rare and endangered relic bush, selected and propagated at the Irkutsk Botanic Garden, are suitable for the beautification of cities and parks (Fig. 3, B) not only in Siberia but also in other regions of the world. So, the BGs working in field of introduction and selection of new plant varieties and forms and keeping the indigenous wild species can share their resources with remote BGs in order to enrich the flora of other regions. Everybody knows about the ancient Japanese traditions connected with the sakura tree (Japanese cherry), with its high national and international reputation. The sakura comes to other countries mostly through the exchange system of the networked BGs. Even if it does not have any value for nutrition, it is a good example of tangible and intangible values of sacred plants and the importance of their introduction into the nearest human environment. Almost each ethnic group in the world has similar plants representing national traditions, national symbols and, thus, the intangibles resources for the community welfare on the national level. So, the introduction of above mentioned and other similar ornamental plants in world BGs is a very important process of establishment, maintaining and keeping of traditions which have an outstanding value for the communities. That is why many world botanic gardens are involved in special plant auctions, plant sales, and fairs for local communities.

Fig. 3. Introduction and reintroduction of plants as complementary functions of botanic gardens. Recent examples of successful plant introductions of edible plant (A - *Armeniaca mandshurica* (Maxim.) Skvorts.) and ornamental plant (B - *Amygdalus pedunculata Pall.*) at the Irkutsk BG. Restoration of damaged populations of rare and endangered plant *Allium altaicum* Pall. in the Lake Baikal region (C – *Ex-situ* propagation, D - repatriation and restoration *in-situ* (in native environment near Lake Baikal) (Photos C and D are courtesy of N.Stepantsova)

For instance, during its 65-year history, the Irkutsk Botanic Garden has evaluated and introduced a great diversity of plants, including more than 400 species of ornamental trees and shrubs as well as more than 300 varieties of fruiting plants (apples, pears, current, etc.), mobilized locally or from the different areas of the world (Kuzevanov, Sizykh, 2005). Such plants are resistant and well adjusted to severe Siberian climate which makes them a good horticultural resource suitable not only for the nutrition and ornamental purposes. They represent a resource for a city greening which has a special value for heavily polluted urban environment in Siberian cities. Greening of the city provides people with better and secure environment, cleaner air. City green zones can protect people from urban noise and sounds.

In comparison with city parks, the Botanic Garden is a place with the highest richness and diversity of plants in Irkutsk (Fig.4). It demonstrates the facts that in a long prospective, the value of the Botanic Garden as source of new genetic resources for the region and improvement human well-being will grow. Thus, BGs' activities on mobilization of genetic resources allow us to enrich the regional cultivated flora with new economically and environmentally important plants. As a result the Botanic Garden has become an exclusive source of high quality nursery-stock of fruit and ornamental trees, shrubs, exotic herbaceous plants, and perennials for regional gardeners and for the network of world botanic gardens. There are many examples when BGs have initiated public activities and traditions for the improvement of the urban environment, helping to establish new "green" businesses to help poor communities to overcome poverty and unemployment, to educate illiterate people and children, and to provide people with skills necessary for the survival, etc.

The world BGs receive monetary and non-monetary benefits through their involvement in public oriented activities and connected to research, education and commercialization of tangible and intangible resources. Such feedback provides a sustainable development of the BGs and, among others, supports the BG's conservational projects on environmental restoration and protection of rare and endangered plants (Fig. 3C and 3D).

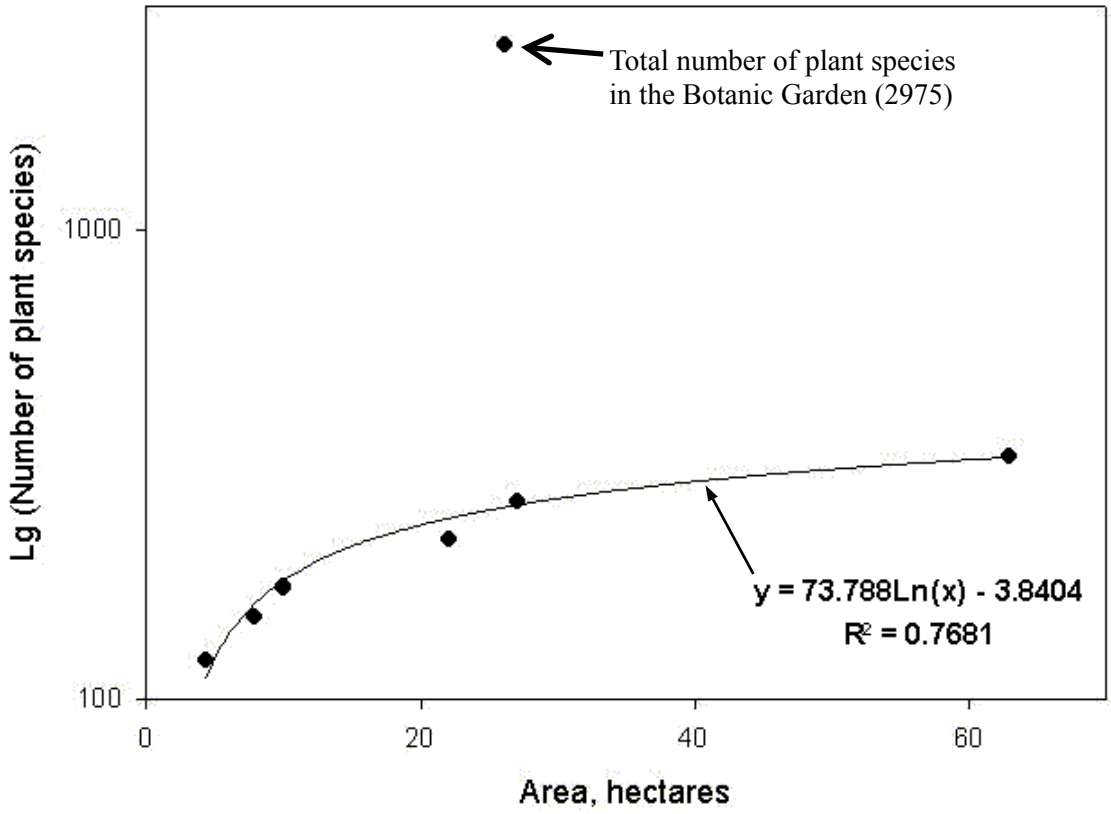

Fig. 4. Comparison of floristic resources of the Botanic Garden of Irkutsk State University with flora richness in Irkutsk city public parks (Kuzevanov, Sizykh, 2005). It is seen that the flora richness in public parks correlates positively with the area of each park (R^2 = 0.768). In terms of floristic diversity, the total number of species in the Botanic Garden is about 5-fold higher which means that Botanic Garden is a prospective source for future development and diversification of green zones and parks in the urban environment which is in particularly important for Irkutsk and other highly polluted industrial cities in Siberia

Table 2. Some examples of how Botanic Gardens Tangible and Intangible Resources can be Related to the Main Aspects of Human Well-being

Aspects of human well-being	Main resources of botanic gardens	
	Tangible resources	Intangible resources
Nutrition	Genetic resources of edible plants (seeds and seedlings for gardeners); demonstration plots. Evaluation gardens and nurseries.	Basic and traditional knowledge and skills about edible plants and how to grow them. Keeping of horticultural traditions of the region.
Healthcare	Genetic resources of medicinally and cosmetically valuable plants (indigenous and introduced). Demonstration plots.	Scientific knowledge and traditional rituals, skills and recipes about cultivation and use of medicinal plants. Legends.
Financial poverty alleviation	Establishment of new 'green' businesses based on plant genetic resources.	Knowledge and skills on management of 'green' businesses including case studies enabling local livelihood alternatives, boosting income.
Community welfare, ensuring freedom and equity for all	Resources for planting trees and shrubs for city 'greening' and beautification of settlements; unlimited access to public resources of BGs for all visitors including disabled ones.	Public activities and traditions promoted by BGs; improvement of interpersonal relations in the community, friendship; transfer of sense of beauty, sense of togetherness.
Education and public awareness	Museums, displays, interpretation, signs, posters, publications, classes, training courses and guided tours, consulting facilities, computerized equipment and media, data bases, libraries, tools, instruments, etc.	Botanical and horticultural information, sharing of skills and technologies, formal and continues education, public activities, environmental propaganda via mass-media and Internet. Public awareness promotion on environmental issues and biodiversity value for human well-being.
Involvement in decision making (personal self-development, self-realization)	Documents outlining the framework of BGs structure, function and activities. Councils and Boards of Trustees, groups of volunteers.	Feeling of freedom and equity for all, an opportunity to take part in management of BG resources and activities, sense of togetherness and responsibility, democratic traditions.
Security	Special facilities and sites at the BGs (garden's complexes, displays, for example, Japanese Garden, Secluded Garden, English Walled Garden, etc.). Collections and nurseries of rare and endangered plants, restored landscapes and new populations of rescued plants in-situ.	Knowledge and skills on creation of special facilities and sites. Sense of peace, calmness, relaxation; feeling of safety, satisfaction. Understanding of BGs value for sustainable development and secure future for mankind.

The Garden's staff and volunteers working for BGs usually provide year-round thematic excursions and guided tours in the open collections and in the educational greenhouses. The employees of the Garden are always ready to provide a free-of-charge advice and consultations about growing, protection, and use of favorite plants. For instance, BGs attract and involve citizens, especially young ones, and tourists in an atmosphere of freshness, an appreciation of nature, in all seasons of the year. Such experience gives long lasting and unforgettable life experience for different groups of visitors. So, in many cases the BGs is functioning as a gate to the virgin and beautiful nature for citizens who spend most of their time in the urban environment.

Due to the fact that the evolution of human beings was always connected with plants and their use for material and spiritual purposes, it is obvious that plants may have a good influence on people. So, in addition to the formal university educational programs for students, the BG of Irkutsk State University in 1994 started development of special extended multilevel education programmes for all levels of the public, including the Horticultural Therapy, for preschool kids, school children, students and adults with different special needs. For instance, the Horticultural Therapy approach based on the experience of a few world botanic gardens (for instance, the Chicago Botanic Gardens, the Canadian Royal Botanic Gardens Hamilton and others) became very fruitful for practical implementation for children and people with disabilities. The wide spectrum of different forms of educational and cultural activities includes: thematic holidays, creative festivals, exhibitions, competitions, etc. There is a broad spectrum of practical exercises and extended activities: training courses, field works and productive practical training, ecological games, etc. So, students from universities and colleges, from the Youth Educational Centre, and from secondary public schools participate in work-study programs and in on-job trainings (Fig.2B, C, D). Secondary schools teachers are taking special classes, trainings, and tours at the BG for their extended professional development. Exchanges of students within the network of world BGs promotes a sharing of expertise, knowledge and skills for further use in other national BGs. Special educational and public programs are being developed for special groups of visitors (orphaned children, disabled, kids at risk with criminal past, older people, and families with children) which became an important part of BG's functions for the improvement of human well-being. In case of orphaned children, the BG can

play a role of the "mother" teaching kids how to use plants in the day-to-day life which is an important issue in the frontier environment (Sizykh, 2001). The "Horticultural Therapy" could be a good example of the implementation of non-traditional educational programs for kids at risk who had a criminal behavior (10-14 years old) and kept in a special isolated school. Special psychological studies since 1999 revealed that the Horticultural Therapy has positive effect on social adaptation and rehabilitation of criminal children participating in the project (Sizykh, Kuzevanov, 2004).

3. Tangible and Intangible Resources of Botanic Gardens for Human Well-being

The roles of botanic gardens and relative institutions in transformation of genetic resources and biological materials into monetary and no-monetary benefits raised from combination of both tangible and intangible aspects of new scientific discoveries, new biotechnologies and resulted plant based products. A feedback from end-users provides a sustainability of the BG's functioning and also reflects a principle of fair and equal sharing of benefits from the biodiversity use.

Local companies, authorities, institutions, nurseries, farmers, green industry enterprises, landscape designers as well as a general public in the region are the main immediate consumers of the tangible resources collected and produced by BGs. Intangible resources (programs, knowledge, ideas, senses, skills, and other non-material things) of BGs have much wider spectrums of end users including not only the local ones but also international customers. Current trends show an increase of the socio-economical and ecological role of BGs recognized as unique complex resource related to different aspects of quality of life and human well-being (Table 2) such as nutrition, healthcare, financial poverty alleviation, community welfare, ensuring freedom and equity for all, education and public awareness, involvement in decision making (personal self-development, self-realization), security.

It is obvious from the Table 2 that resources of BGs have a special environmental, scientific, cultural, aesthetic, and recreational importance. Both tangible (material) and intangible (non-material) resources of BGs are equally valuable for the sustainable development and linking biodiversity with public education, secure environment, nutrition, healthcare, poverty alleviation, socio-ecological and economical relations in

communities, including commercialization.

Therefore intangible aspects of BGs are as important as their tangible ones and they can not be discriminated in relation to human well-being.

4. World Botanic Gardens and Human Development

Contemporary global, inter-regional, and national networks of about 2200 world botanic gardens in 153 countries represent a unique community of diverse institutions (governmental, private, municipal, academicals, university, etc.) which were united mostly around the idea of conservation and rational use of plant genetic resources.

Distribution of significant BGs worldwide (Fig. 5) reflects a development of civilizations and biodiversity patterns on Earth (Barthlott et al., 1999). About 60 % of BGs are located in northern hemisphere (Europe, North America, part of Asia) whereas sites with the highest biodiversity are in the south. Such distribution was developed historically (An international review, 2001). At the moment world botanic gardens are holding living plant collections of about 4 million of species. Individual BG's collections and displays vary from hundreds up to tens thousand taxa collected locally or introduced from other regions with similar conditions.

The numbers of botanic gardens in each of 153 analyzed countries show a positive correlation with human development indexes (HDI) of the countries (Fig. 6). The HDI is one of the widely used integral quantitative characteristics for the estimation of human well-being status in different countries (combining indicators of life expectancy, educational attainment and income) and it can be used for comparative purposes only (Human Development Report, 2004). From the graph on Fig. 6 it is possible to make a few obvious conclusions about BGs as instant resources of biodiversity and about their possible connections with human well-being. The numbers of established BGs in the country positively correlates with the level of human development for majority of countries with a few exceptions. Exceptions seen above the main "cloud" of data points are rather related to the size of the country population and size of the country, etc. There are few examples of exceptional large numbers of BGs and arboreta per country: A) In India (126) and China (144) which have abundance of people and have developed technologies and real demand in biodiversity resources; B)

In Russia (108) where many BGs left as the ex-USSR national heritage, scientific and educational tools and as a result of previous development and understanding of the BGs roles for human well-being; C) In Australia (126), the U.K. (105), Italy (105), Germany (102), France (95), Canada (94), and other highly developed countries; D) In the US (367) numerous new BGs and arboreta, especially university ones, have been established in late 50s and early 60s as a response to the first launch of the Soviet Sputnik (a satellite) because the American government realized that university BGs and astronomical observatories are an important part of the continuous scientific education for the development of highly qualified "labor forces/resources" (human beings, people).

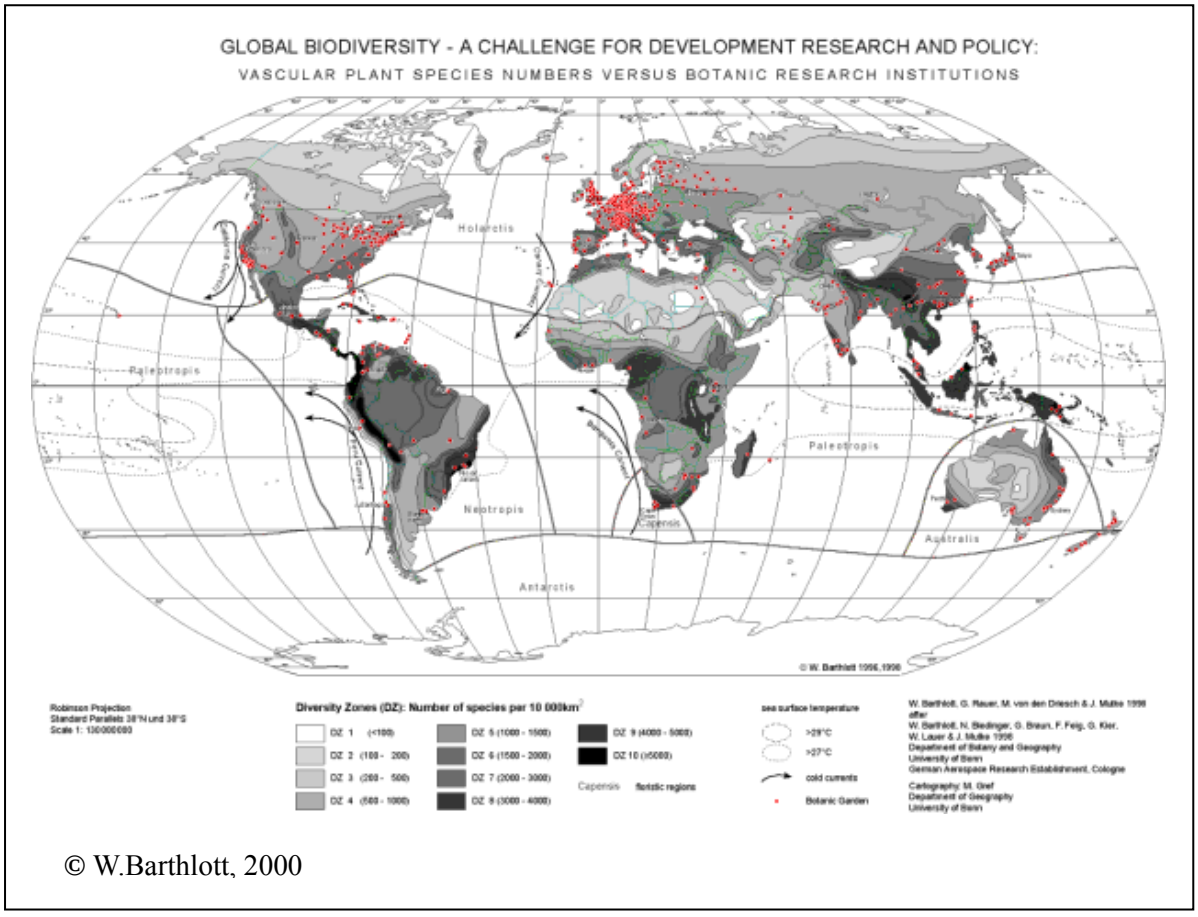

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Fig. 5. Distribution of registered botanic gardens worldwide (shown as red dots) in relation to global distribution and richness of higher plant species on Earth (from W. Barthlott et al., 1999; courtesy of the Bonn Botanic Garden)

At the same time several well developed countries have just a few or even no BGs which means that probably some other institutions (nurseries, parks, private gardens) take/replace the role of traditional BGs in these particular area of human activities and human being. Some very poorly developed countries with the HDI <0.3 cannot afford to have BGs capable to meet international standards (Afghanistan, Aruba, etc.) but even some of them maintain BGs as a national heritage valuable for people (Bangladesh, Sri Lanka, etc.). There is a visible gap at the HDI 0.55-0.65. Low-and-middle developed countries (HDI from 0.4 to 0.6) and highly developed countries (HDI >0.7) are separated into clearly visible two main groups (or two "clouds of data points"). It is an interesting problem for further study of differences in functions and roles of BGs in these two groups. And it is a prospective question for further studies of different tangible and intangible aspects of environmentally, recreationally and technologically valuable resources of BGs in relation to their roles in improvement of people life.

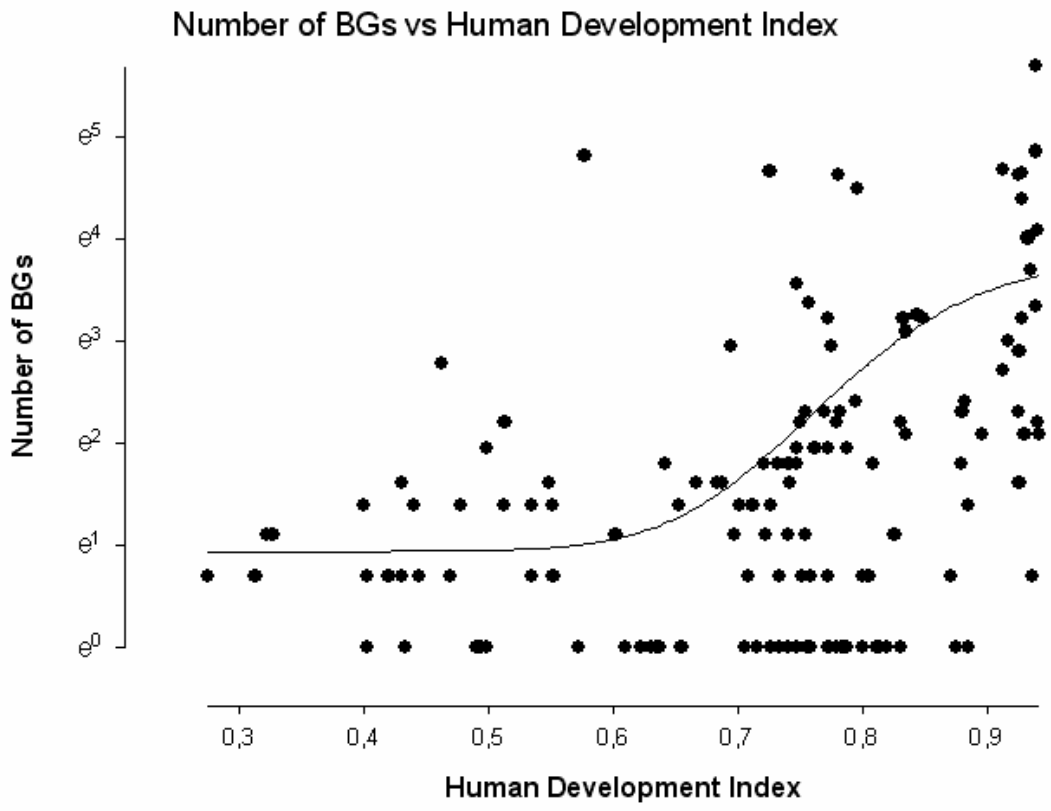

Fig. 6. Relation of the numbers of world botanic gardens (from the BGCI data base) and the human development index (HDI, 2004) in different countries

5. Conclusions

Since biodiversity is one of the fundamental cornerstones for human well-being and sustainable development, any institution involved in biodiversity issues should be an important player on national or international levels depending on available resources and its mission. The involvement of any BG in national, inter-regional and international networks makes its position stronger and more flexible, due to ongoing exchanges of tangible and intangibles resources between world BGs (Fig. 7). Positioning of BG in a system of the circulation of plant genetic resources (tangibles) and associated knowledge, traditions, ideas and skills (intangibles) for conservation, mobilization and use of biodiversity can not be underestimated. BGs play complementary dualistic roles in biodiversity conservation and ecological innovations for improvement of human well-being.

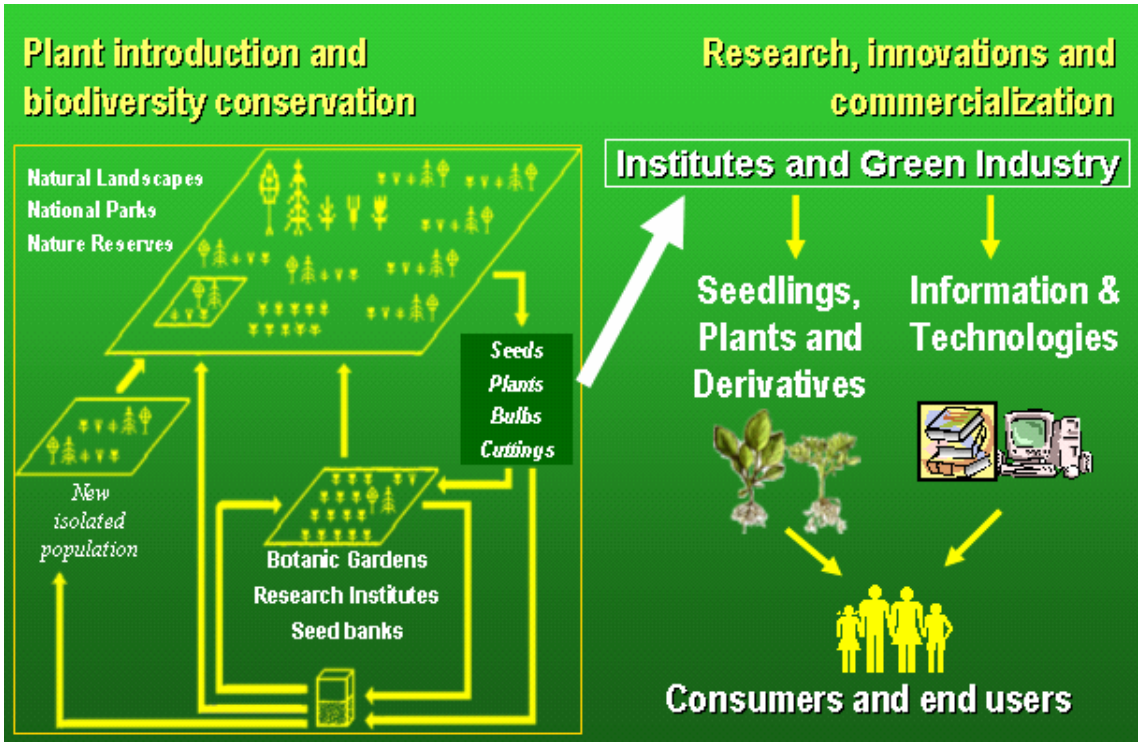

Fig 7. Positioning of the BG in a system of the circulation of plant genetic resources (tangibles) and associated knowledge, traditions, ideas and skills (intangibles) for conservation, mobilization and use of biodiversity. It shows a complementary dualistic role of the BGs as a part of biodiversity conservation and genetic resources turnover (left box) and other innovative outputs for improvement of human well-being (right box)

A traditional view on the BG (Fig. 1) which served as a pattern or the classical model and interface between nature and people is changing dramatically due to ongoing diversification of BGs and their active involvement in globalization. And we are seeing a process of the changing paradigm of the BGs especially in tangible and intangible aspects of their functioning as well as in their concept and practices for the community. The role of BGs as intellectual and cultural centers is increasing. It is a challenging period of time when the roles of BGs go beyond the traditional limits.

In this context we would propose an overall scheme to demonstrate the crucial roles of a feedback in the management and transfers of tangible and intangible resources which are equally valuable for linking biodiversity (natural heritage) with market economy and human needs (Fig 8) through research, education, conservation and commercialization.

It is necessary to emphasize, that any modern BG is not just a beautiful park or a channel for the transfer of pure knowledge and theoretical skills because such knowledge and "know-how" cannot be delivered just through books or Internet. Only through practical works and activities the BG can transfer skills and experience connected with traditions and best practices in certain regions. Such transfers and mutual sharing need a personal communication between humans in practical actions. Due to the intrinsic peaceful nature and a positioning of BGs in the society they have an important factor of formation of peace traditions at young generation and steady transfer of these traditions through generations.

Since biodiversity has varying patterns at continental and global scales (Mutke, Barthlott, 2005), BGs activities vary with local and global tasks.

In the new ecological and economic conditions of globalization the role of BGs will be increased substantially due to their well developed networks, traditions of free exchange of tangible and intangible resources, direct involvement in the community and direct contacts to the nature. They are becoming an important part of regional ecologically significant resources and elements of regional productive forces for human well-being and sustainable development.

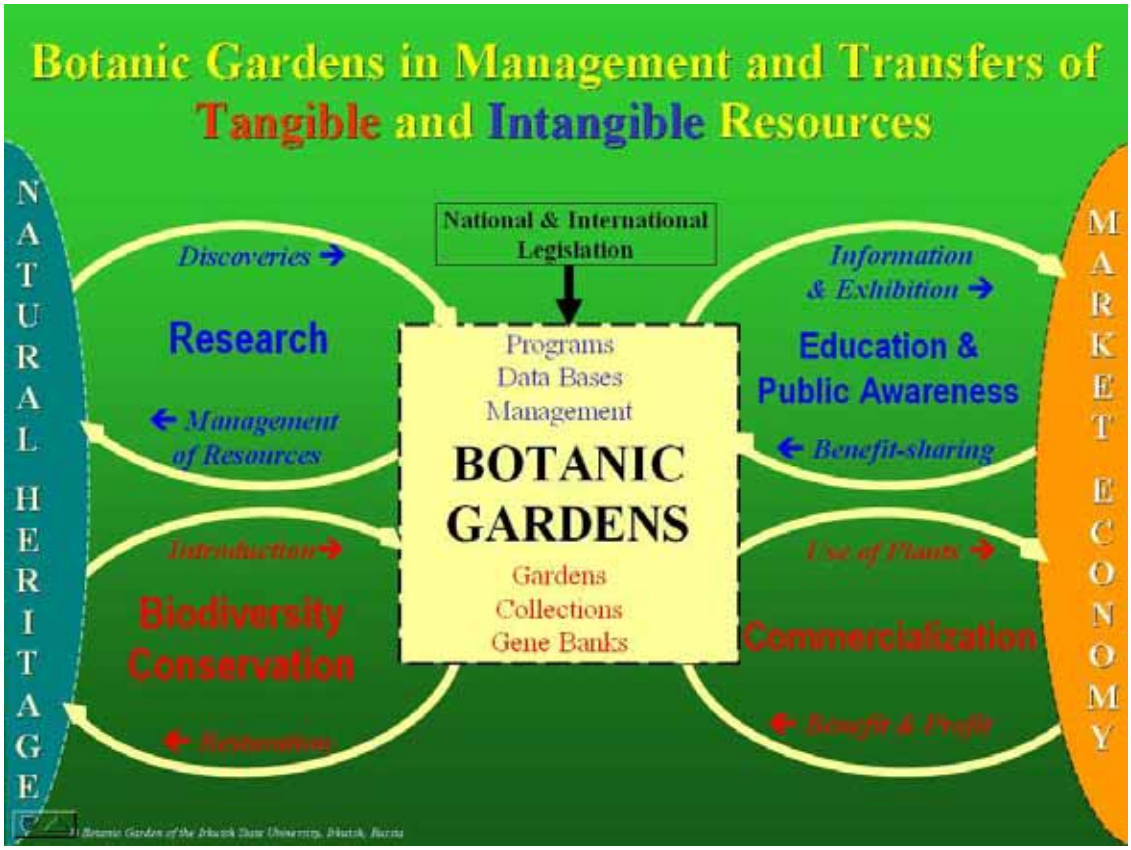

Fig. 8. Botanic Gardens in Management and Transfers of Tangible and Intangible Resources. Red color emphasizes the tangibles (mostly material things) and blue color emphasizes intangibles (non-material things). It is obvious that both intangible and tangible aspects are equally valuable for the botanic gardens functioning as an active interface between natural heritage and people needs

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