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VEGETATION DEGRADATION AND DESERTIFICATION IN YEMEN

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ABSTRACT

Yemen, which lies in the extreme Southwest of the Arabian Peninsula, is characterized by tropical arid to semi-arid climate. Its altitudinal range (0-3760 m) is largely responsible for the differentiation in the climate and provides different phytogeographic region. An estimated number of more than 3,500 plant species has been reported and about 10% of them is said to be endemic. Precised data on the status of the rare and endangered species has not yet clearly verified. The vegetation of Yemen is largely influenced by man's impact and other environmental cause of vegetation degradation. It has been estimated that about 90% of the country's total area is suffering from desertification at different degrees. The Desertification areas in Yemen, especially in Tihama, Marib, Al-Jawf and other southern coastal areas is nearly 14-20 ha/year.

INTRODUCTION

The general aim of this study is to define the state of Yemen's Floral biodiversity and/or vegetation; identify the effect of human impact and other processes which threaten the vegetation and/or floral biodiversity; and to find out gaps and recommend initiatives for the conservation of such natural resources.

The archaeological data indicted that man has settled Yemen for a very long time. This earlier settlement caused gradual changes on the environment of the country, especially the vegetation. Evidence of vegetation degradation is indicated by the sporadic remnants of forest trees in different areas of the country. This decline in the vegetation cover is, in recent time, more rapid than ever before due to the drastic soil erosion, lack of seeds for regeneration and other causes of desertification.

The desertification and drought are considered the most old environmental problem, in the country, especially in the recent centuries. This phenomenon threaten the main human source of life

such as: water, soil, vegetation cover, agricultural lands etc. Some of the Main factors lead to the desertification are: climatic changes; topography; misuse of natural resources and abandonment of the agricultural lands due to the migration.

LOCATION, TOPOGRAPHY AND CLIMATE

Yemen lies in the extreme southwest of the Arabian Peninsula. It extends between latitude 12 40 and 19 00 North, and 42 30 to 53 05 East longitude and covers about 555,000 sq. km. (map1). Information of the various topographic regions is reliable, but classification of these regions has not been uniformly adopted. Hepper (1977) subdivided the northern part of the Yemen into five major zones: Coastal plains; Western escarpment; Southern mountains; Mountain plain; Eastern mountain and deserts. Al-Hubaishi and Muller-Hohenstien (1984) divided the area into six regions: Tihama (0-300m); Tihama foothills(300-1000m); Lower escarpment (1000-16000m);Higher escarpment (1600-2200m); Highlands and high mountains (2200-3700m) and Eastern semi-desert and desert (2200-1800m). A recent study on the vegetation of Yemen made by P. Scholte, A. Al-Khulaidi and J. kessler (1991) identified eight main landscapes for the western part of the country (map 2): Tihama coastal plain (0-30); Tihama foothills and low altitude western mountain (<1000m); Medium altitude western mountains (1000-1800 m); High altitude western mountains (>1800m); Highlands plains (>2000m); High altitude eastern mountains and highlands (>1800m); Medium altitude eastern mountains and highlands (1200- 1800m) and eastern desert plain (<1400m).

The Southern Part of Yemen is not comprehensively and/or ecologically studied. Nevertheless, it has been divided into five zones: the Coastal plain (0-200m); the Mountains plateaux (200-800 m); the Mountains regions (800-2000m); the Interior foothills (500-1000 m) and the desert (up to 1000m).

Topographically, the following geographical division and/or ecological zones for the Republic of Yemen will be followed in this study (map 3):

1- The coastal plains

a. Western or Tihama plain (0-300m): It extends about 420 Km. Along the Red Sea; 50 km. sq. wide at the north and 20 km. sq.

At the south. It covers an area of about 14,700 km sq. (2.6% of the Yemen total area)

b. Southern plain (0-200) m): It extends about 1580 km. Along the Gulf of Aden and the Arabian Sea; 15 km. wide at the west and 60 km. at the east. It covers an area of 44240 km sq. (9.7% of total area).

2- The lower altitudinal highlands:
   a. Tihama foothills (300-1000m): comprise the western lowlands and the escarpment facing the Red Sea.
   b. Southern Plateaue (200-800m): comprise the southern lowlands facing the southern plains and Arabian Sea.

3- The medium altitudinal highlands:
   a. Western highlands (1000-1600m): All highlands located west hajjah and Mahweet; around J. Milhan and J. Bura; highlands around Madinat Al-Sharq and Taiz and west of Huth and Al-Makhadir.
   b. Southern highlands (800-1800m): comprise the highlands of Al-Dhala, Mukarias, lower Yafe, lower Awaleq, lowder, Modia, Harf, J. Eraf (Hujjaria), J. Al-Arais(Abyan), J. Jehaf and Hadramout plateaux.

4- The high mountains
   a. Northern highlands and high mountains: (2200 - 3700m): highlands of Ibb, Rayma, Dhamar, Sana'a, Hajjah. J. Allawz (E. Sana'a), J. Al-Nabi Shuaib.
   b. Southern highlands and high mountains (1800- 2200m): mountains of Sabir, Al-Turba (Hujjaria), J. Abran, Mukairas, high Yafe.

5- The highland plains
   a. High altitude plain (>1800m) includes plains of Rada', Dhamar, Qa-Bakil, Sana'a, Sada'.
   b. Low altitude plains (<1800m): include: plains of Al-Qaida, Qa-Al-Haql, Qa-Shehara.

6- The eastern mountains
   a. medium altitudinal mountains (1200-1800m); comprise mountains gradually slope toward the eastern desert such as: mountains east of Sa'ada, west Marib, North Albaida, around Baihan and north Ataq.

b. High altitudinal mountains (>1800m): comprise the mountains separate between the wadis flow towards the west (Red Sea) and wadis flow toward the east (desert) such as: mountains east of Dhamar and Amran plains, east and north Rada, between Rada and Baida and between Abyan and Baida.

7- The eastern desert (1000 - <500m): includes the areas east and north of Marib and Ramlat AL-Sabatain.

Because of the geographic location, Yemen is characterized by tropical arid to semi-arid climates. The climatic differentiation is partially due to its borderland situation between the tropical and subtropical climates. The climate and soil are largely influenced by topography which lend a great richness to habitats. The main reason for the high floristic richness are the very different landscapes of the country; sandy semi-desert with salty plains near the coasts; stony slopes and rocky outcrops in mountains ridges; loamy basins in the lowlands and the stony pediments in the highlands. The altitudinal range from sea level up to 3700m is responsible for the differentiation of appreciable types of climate, which provides different phyto-geographic regions.

Rainfall and temperature are the most important factors for plant life and almost everywhere in Yemen moisture is the minimum factor and therefor the most determinate ecological factors. Nevertheless, there are marked differences concerning this factor. The coastal plains climate is very hot, very humid with a mean annual temperature over 30C and rainfall up to 200m. The lowland climate is very dry, frost-free, high humidity, with a mean annual temperature between and above 30C and precipitation up to 400mm. The highland climate is a semi-arid tropical with low humidity, frequent frost during nighttime in winter, mean temp. above and below 15C with precipitation ranges from 400-800mm. The semi-desert to desert climate is generally known as low rainfall regions (<200mm) with low humidity of air and a mean annual temp. above and below 25 C. Since Yemen comes under the influence of the tropical summer mansoon (SWandNE), most rainfalls, in the form of heavy thunderstorms especially during summer with peaks in April/May and July/August.

FLORAL BIODIVERSITY IN YEMEN

Flora of Yemen and Its Relations to the Floral Regions of the World:

Botanists and/or phytogegraphers consider the boundary between the Paleotropic and Boreal (Holarctic) Kingdom lies somewhere north and east of the mountains ridges of the southwestern Arabia. Hence, the mountains and the Red Sea coast are considered part of the Africa, whereas the desert lie in the Saharo- Arabian region of the Holarctic kingdom (map 4).

Because of the geographical location, Yemen has floristic elements common with East African Highlands, Sahara - Arabian region, the Mediterranean region and has its own endemic. The Sudanian elements (African Plains) predominates in the western mountains and part of the Highland plains where annual rainfall is above 250 mm and with semi-arid climate. The Saharo- Arabian elements dominates in the drier areas with an arid climate and rainfall less than 250 mm (The Coastal Plains, Eastern Mountains and the Eastern Desert Plain).

Less than one-third of the plant species in Yemen are belong to the Sahara- Arabian plant geographic region (i.e. extra tropical) and the remaining species are tropical African (Sudanian) region. Botanists recognized close floristic affinity between the flora of Yemen and that of the North-Eastern Africa which allow the so-called "Eritreo-Arabian Region" to be identified (comprises Yemen, Ethiopia, Somalia , Djibouti, Southwest Saudia Arabia).

The Floristic Basis of Yemen

The flora of Yemen is very rich and heterogenous. The species diversity is a result of considerable climatic changes in former periods which enable different species to survive in the different ecological habitats . The exact number of plant species is not precisely well determined, because flora itself is not yet precisely and comprehensively studied.

An estimated number 2000- 2500 plant species has been reported for the northern governarates, 5-10% of them is said to be endemic (Al-Hubaishi and M. Honenstean, 1984), The literature and collections available showed a lesser number than that recorded. The studies compiled for the Northern part of Yemen by Al-Dubaie, A. (1993, 1995, 1996, 1997) comprises 1551 plant species (including

Cryptograms and Phanerograms) related to 681 genera and 139 family. Among these, 93 species are endemics, and 16 species are rare.

The largest families as indicated by A. Al-Dubaie , (1996) are Poaceae (C.229 ssp.), Asteraceae (C.122 spp.), Leguminoseae (C. 115 spp.), Lamiaceae (C. 51 spp.), Asclepediaceae (C. 49 spp.) Euphorbiaceae (C. 47 spp.), Brassicaceae (C.42 spp.), Boraginaceae (C.38 spp.), Cartyophyllaceae (C. 35 spp.) and Acanthaceae (C. 34 spp.).

The largest genera are Acacia (27 spp.) , Eragrostis (22 spp.), Euphorbia (20 spp) , Solanum (18 spp.) , Brachiaria (17 spp.) , Caralluma (16 spp.) , Aloe (15 spp) , Heliotropium (15 spp.) . Pennisetum (14 spp.) , Sporobolus (14 spp.) , Ficus (13 spp.), Indigofera (13 spp.) Grewia (11 spp.) and Commiphora (10 spp).

In the southern governarates, the flora is estimated to be 1180 plant species , fifty to eighty species (5-8 %) of which is considered as endemic (A. Miller and T. Cope, 1996). The checklist compiled by S. Gabali and A. Gifri, (1990) comprises 467 plant species belonging to 244 genera from 71 family.

Socotra Island is unique in its flora and like many oceanic islands, has a high level of endemism. The latest study is compiled by A. Miller and T. Cope (1996) which reported that Socotra contains approximately 820 plant species, 240 of which are endemic (30%). Out of the eighteen genera endemic to the flora of Arabian Peninsula, eleven genera are restricted to Socotra archipelago.

Pricised data on the number of endemic species in Yemen are not available , but probably the number can be more than three hundred species. However, endemism is generally very high amongst the succulent plants. The largest numbers of endemic species are found within the Asclepediaceae because of the Stapeliad genera (Caraluma, Duvalia, Huernia, and Rhytidocaulon). Euphorbiaceae and Aloeceae have high percentage of endemism because of the succulent Euphorbia and Aloe species respectively. After Socotra which contain about 30% of endemic spp., Al- Hujariyah region (Taiz Province) is considered the richest with about 99 endemic spp. The majority of endemic taxe in Yemen are associated with mountainous areas, which provide a rich variety of ecological niches and offered a degree of environmental stability during periods of climatic changes (A. Miller et al. 1996)

Precised data on the status and/or number of rare and endangered plants are not available. The primary source of information on these critical species in the outdated IUCN listing, which has not received verification through the field research. However, taxonomists recorded a number of Indigenous species which considered as rare or local in its distribution.

Endangered species (or rare) mentioned in the Red Data Book are:

- *Aloe squarrosa - Socotra.*
- *Bignonia socotrana - Socotra.*
- *Dendrosicyos - socotranus - Socotra.*
- *Dirachma socotranus - Socotra.*
- *Dorstenia gigas - Socotra.*
- *Euphorbia abdelkuri - Socotra.*
- *Punica protopunica - Socotra.*
- *Taverniera sericophylla - Socotra.(was considered as extinct)*
- *Wissmannia carinensis -Southern part of Yemen .*

Endangered or rare species at national level are also reported as follow (D. M. Varisco, et al. (1992):

- *Aloe sp.*
- *Acacia laeta*
- *Adnasonia digitata*
- *Alkanna orientalis (abundant at highlands)*
- *Adenia sp.*
- *Caralluma sp.*
- *Cerepegia sp.*
- *Commiphora opobalsamum*
- *C. mukal .*
- *C. parciflora*
- *C. socotranum*
- *CrinumYemense (all over highlands)*
- *Delosperma harazanium*
- *Dracaena sp.*
- *Duvalia sp.*
- *Eulophia sp.*

- *Euphorbia fruticosa (found abundant around Shibam)*
- *Juniperus procera (abundant in J. Eraf, Hujjariah)*
- *Huernia sp.*
- *Kniphofia sumerae*
- *Oncoba spinosa*
- *Ochna inermis*
- *Plectranathus hadiensis*
- *Rhytidicaulon sp.*
- *Taverniera sericophylla*

Trees and shrubs considered rare by Wood, (1983) are:

- *Antiaris taxicaria*
- *Barlaria bispinosa (may be B. proxima)*
- *Bauhinia tomentosa*
- *Ceiba pentandra*
- *Cussonia holstii*
- *Dombeya schimperiana*
- *Nuxia congesta (it's found in Taiz)*
- *Nuxia oppositifolia*
- *Ormocarpum yemenense (it's found allover the highlands)*
- *Pouzozia mixta*
- *Trema orientalis*

Plants species recorded as an extinct by Wood, (1983) are:

- *Ailanthus excelsa*
- *Celtis integrifolia*
- *Entandrophragma angolens*
- *Podocarpus gracilis*
- *Pygeum africanum*

Endangered and/or rare species are given more attention by most taxonomist locally and at international level. Such plants are of high priority for protection.

Plants used in traditional Medicine:

The Republic of Yemen owing to its location and geographical region, its flora especially medicinal and aromatic plants are of great interest. There are accumulated experiences in using these plants as traditional remedy to cure an endless list of diseases occurring in different areas of the country. The medicinal flora in Yemen is not well

known and research work on traditional medicine is still limited. However, a limited number of plants were being used in traditional medicine as remedies for certain diseases. Others were used as cosmetics, condiments, coloring matters, flavoring agents. Among the most common plants being used are; Cassia senna (laxative); Zizphus spina- christi; (antiseptic) ; Lawsonia inermis (antiseptic and cosmotic); Mentha longifolia (digestive disorder); Withania somnifera and Solanum incanum(dental analgesic); Anisotes trisulcus (for kidney- stones). A list of 224 medicinal and aromatic plants species along with their scientific names, family, vernacular names, distribution, active substances, medicinal part and medicinal use is compiled by A. Al-Dubaie, (1993). A similar study concentrated on the use of medicinal plant endemic to Yemen was also done by A. Al-Dubaie, (1995).

The Vegetation Degradation and Desertification

The natural vegetation for the main natural regions of Yemen can be described briefly in terms of plant formation as a semi-desert dwarf-shrub-land; evergreen broad-leaved woodlands and forests in the higher areas; drought-deciduous woodlands in the higher mountains; semi-desert mountain shrub-land in the east; and finally some annual herbs and grasses in the desert.

Most of the natural vegetation in Yemen has been strongly disturbed and degraded and in some areas are replaced by introduced species. Because of the human influences, only very few relics of these vegetation formations can still be found. Man's influence on the vegetation cover in Yemen was and still more effective than any other ecological factor such as climatic or edaphic factors. The man impacts on the vegetation and/or flora is generally the result of different interrelated activities such as: demands for agricultural products, firewood, timber for construction, grazing and building agricultural lands.

The study, which was conducted by Hunting Technical Company (1992), stated that, the vegetation cover and woodlands in Yemen cover about 2.4 million hectar; 2 mil. ha. is woodland and 0,4mil. ha. is agroforestry area. These resources are regionally distributed as follows: Foothills and western highlands 76%; Central highlands 17%; coastal plains 7% and Al-Mahara about 0.7%.

The desertification and drought are considered the most important environmental phenomena, which cause vegetation degradation. The vegetation degradation and plant species threatening are increasing drastically, especially in the last three decade. Studies conducted in Tihama between 1973-1992 indicated that Acacia woodlands showed noticeable decrease (20-30%). Aerial photos on Jabal Bura (western mountain) showed that woodland had been reduced by annual rate reaching up to 4% of the woodland total area. During the period 1973-1988, woodland degradation in Jabal Bura reached about 60%. The woodlands in Jabal Eraf (Al-Hujariah, Taiz Governorate) are badly affected by cuttings and the dying phenomenon especially the Juniperus trees. The main causes and factors of desertification and/or vegetation degradation could be attributed to the following:

Cultivation / Agriculture Practices:

Because of the domestication of cattle, income improvement, food-need compliance, in addition, to the agriculture as an important activity in most parts of the country, many shrubs and tress had been removed from the plains, basins, hillsides and mountain slopes except of single trees for shades. Removal of trees and shrubs from these places is, to be replaced by qat, vegetable, fruit trees, fodder plants and other profitable crops.

However, poor agricultural practice is also another factor that cause severe degradation for the vegetation in most areas. For instance deep plowing and/or plowing along the flow lines causes soil erosion. In addition, the mono-crop farming system leads to reduction of soil fertility. The former migration of Yemeni farmers from rural areas into neighboring countries led to the virtual abandonment of the traditional sophisticated systems of terraces in the mountains resulting in serious soil erosion and tress and shrubs removal. Another factor caused terraces abandonment could be low rainfall, drought, floods, high cost of production inputs, low yield and outputs and high cost of maintenance. Studies on terraces indicated that 20-40% of the agricultural lands in the mountains regions such as Al-Hujjariah, Hajah, Al-Mahaweet are abandonment

Grazing:

It has been reported that more than twenty million animals including goats, sheep, camels, cows, donkeys, are exist in all over the

country. Because of the absence of laws and legislation that control the over grazing a degradation and/ or destruction of plants covers from many places all over the country have been noticed. Not only that some species disappeared, but inhibition of regeneration of woody vegetation, changes of natural conditions of competition among plant species of certain community and the gradual replacement of palatable species by undesired species or even toxic are a direct effect of the overgrazing. In the drought season shepherds usually cut trees branches especially Acacias, Ziziphus sp., Dobera glabra, for stock feeding. Such cutting or loping might not only cause harmeful damage but also might reduce trees seeds production.

Wood Cutting:

Traditional sources of fuel are still dominated in many rural areas, in-spite of availability of gas in some areas. Firewood is obtained by burning trees, whole cutting of trees /shrubs, and uprooting of the dwarf-shrubs. The demand for firewood is increasing and has been used as business in many places, especially Tihama and around Taiz, which will destroy the remnants of the former forests and open woodlands. Wood is utilized for fuel charcoal, construction purposes, and agricultural tools.

Wood cutting changes the vegetation composition of the remaining woodlands, too. Many trunks-forming trees, for instance, are already replaced to a large extent by small shrubs. In the central highlands, where population is high, the vegetation is almost become very limited, if not completely destroyed due to wood cutting and the high price of the firewood. It is likely that more rapid change in the vegetation cover is taking place day after day, unless suitable actions are taken very quickly.

Previous studies indicated that nearly the whole Yemen, with the exception of rock out-crops, mobile sand dunes, salt pans and the highest mountain peaks, was at one time covered with forest (Hepper and Wood, 1997). Recent studies showed that the remaining forests are nearly have less than 7% compared to the forests of Yemen in the past.

Wind erosion and Sand dunes encroachment:

These two phenomena are considered as features of desertification. The Al-Rubu-Al-Khali (southeast of the country) and Ramlat Al-Sabatain (east of Marib) are considered areas of sand accumulation and a dangerous source of sand. The encroachment of sand can be seen in

Tihama plains, Marib, Al-Jawf, Lahj, Abyan, Shabwa, Hadramout, and Al-Mahara. This dangerous phenonmena covers about 4 million Hectar and its annual rate 40m/year. It causes a socio-economic disasters because of its effect on agricultural lands, irrigation channels, roads, towns, villages and other developmental infrastructure. In the coastal areas of the country studies indicated that sand covers about 600-950 ha. and threatens about 2000ha. In the early of 1970s, sand covered about 2250 ha in Wadi Abeda (Marib) which reached up to 9840 ha in 1990.

Soil Salinity:

The inappropriate irrigation practices and the unwise use of underground water result in the salinization of soil and/or agricultural land in many areas of the country especially the coastal areas. In the southern part of the country, where the rainfall is low and temperature and evaporation are high, about 90% of the land is threatened by salinity. This problem which result in reduction of agricultural land and decreasing of production is noticed in Wadi Hadramout and other coastal areas such as Al-Hodiedah, Al-Makhah, Abyan, Dawhan etc.

Construction Expansion in Cities and Villages:

Due to the demographic growth and desire of investment, the country witnesses various constructional expansions such as buildings, roads, factories etc. The high demand for land, and high prices, lack of urban planing and absence of construction legislation and laws, illegal construction on expense of agricultural lands, woodland and range-land resources has been decreased. This phenomenon has been clearly seen in the outskirts of Sana'a, Taiz, Hodiedah, Aden, Ibb and other cities and villages.

Cement Dust Pollution

Studies on the effect of cement dust on the vegetation growing around the cement manufactories showed that the vegetation is positively affected by the dust accumulation on the plants leaves and flowers. The chemical analysis of the cement dust showed that the toxic chemical materials inhibited plant growth and metabolism and limited the vegetation cover of the areas around the manufactories (Al-Monyeri and Al-Dubaie 1995).

CONCLUSIONS AND RECOMMENDATIONS

The main conclusion of this study is that the floral biodiversity and/or vegetation of Yemen is being drastically reduced by the rapid degradation of the environment. This degradation of vegetation cover and natural resources is a direct result of desertification. The desertification and drought are considered the oldest global environmental phenomena which cause vegetation degradation. These phenomena are increasing drastically in Yemen and threatening about 90% of the land especially in the coastal areas. The desertification has many forms and features and can be attributed to the following:

- Cultivation and poor agricultural practices.
- Wood cutting for firewood , timber and charcoal.
- Over grazing.
- Terraces abandonment.
- Soil Salinity.
- Wind erosion and Sand dunes encroachment.
- Construction expansion in cities and villages.

The floral biodiversity and/or vegetation cover of the country started to be affected by the rapid degradation of the environment. Many plant species, especially endemics are exposed to extinction and rare species are increasing day after day. The overall development policy and actual direction of development in the country have ignored the environmental consequences of changes.

There are no adequate legislations, regulations and laws protecting critical habitats and natural resources for the sustainability of biodiversity of the country. The desretification has many serious consequences on the natural development and on the socio- economic factor such as: reduction of natural income, migration, unemployment, poverty and food problems and dependency of imports.

In the light of the above mentioned problems the following general recommendations could be mentioned:

- Developing a national strategy and an action plan for the conservation of biodiversity in Yemen which include an assessment to the bio-diversity; the basic data available; human impacts on the biodiversity; economical importance of natural resources; the current status of laws and legislations conserving natural habitats and the desertification impacts.

- Establishing affiliation with a Yemeni institutions and initiate projects under existing international programs concerned with Bio-diversity and desertification.
- Promoting conservation awareness , using the media to raise people awareness on the importance of conserving the natural resources and the danger of human misuse of these resources.
- Defining the nature and level of protection needed for conservation of critical areas before establishing formal parks or reserved.
- Documenting all publications and/or researches related to the natural resources ; bio-diversity; ecology; forestry; conservation; desertification; environment protection; pollution; human impacts ...etc.
- Defining the critical species for conservation especially those listed internationally as threatened species.
- Providing scholarships and trainings for qualified candidates in the area of environmental science
- Creating and emphasizing an adequate laws and legislation for protection of flora, forests, vegetation , critical species, natural habitats in Yemen.
- Establishing a Yemeni Biological Society or National History Society to gather the scientists under this umbrella. The society members should collect data, make survey to the natural resources of Yemen and to conduct researches in different aspects of biology and to initiate activities related to the conservation of the natural resources and environment.
- Establishing a national herbarium to be as a reference for the flora of Yemen.
- Establishing botanic gardens in different ecological zones to be as a gene bank and for researcher purposes.
- Establishing a national bank for genetic resources and initiate activities for collection, preservation, classification, evaluation and improvement of the hereditary resources.

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