

Soil and Water Conservation Implications on Soil Security and Civilizations Decline

—Commented by José Luis Rubio, An International Famous
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The mismanagement or abandon of soil and water conservation systems is a crucial factor triggering soil security consequences including the decline or even the collapse of civilizations. This paper is a wide reference review. The objective of this paper is to analyze implications of soil and water conservation on soil security and civilizations decline from the point of view of man's relation to productive soil in world history. Some conclusions are based on logic rather than in known facts. But we consider that the basic arguments and conclusions are sound and reasonably correct.

1 Threatening Factors, Implications and Achieving Measures of Soil Security

Soil security that can be analyzed from the perspective of state, human, and environmental security refers to the depletion of the soil capacity to provide foods and ecological functions that puts in extreme cases—the survival of affected people at risk.

(1) The five dimensions of soil security include: capability (functionality), condition (soil health), capital (monetary, ecosystem services), connectivity (social dimension of soil) and codification (policy and regulations). Soil security is a multidimensional issue; environmental, economic and social; Soil security is the extra dimension of soil degradation affecting primordial aspects of human life.

(2) Soil security is threatened by: ① the severe degradation of soils and related fertility and biodiversity; ② the loss of soil capacity to regulate & store water; ③ the climate impacts and changes (including drought) and human mismanagement. All of those could lead to bad harvests and crop yield declines. That has triggered severe and extended periods of famine affecting several billion people and causing the death of millions of persons.

(3) Soil security implications include: ① access to primary resources for subsistence; ② access to land, land tenure, technical knowledge and resources; ③ sufficient quantity and quality of food to all people at all times; ④ adequate nutritious diet for

a healthy life. In other words, soil security can affects essential human needs.

If lacking the previous implies, the results could be: ① poverty, hunger, famines, social and political instability; ② conflicts, violence and wars for scarce or degraded arable land; ③ forced migrations and displacement; ④ decline or collapse of social and political structures.

(4) Soil security is achieved when efforts succeed in the following areas: ① containing land degradation and applying adequate soil conservation management to conserve soil fertility; ② when the consequences of soil degradation are reduced by improving livelihood and human well-being of the people.

Soil security is the assurance to access to basic soil resources that can provide food, and ecosystem services to meet essential human needs for healthy living.

2 Some Historical Collapsed Antecedents of Ancient Societies and Civilizations

There have been 10~30 different civilizations that collapse. The four interesting and illustrative civilizations are as follows: ① Indus Valley Harappa; ② Mesopotamia and the Fertile Crescent; ③ Mesoamerica (Olmec, Maya, Chacoans, Huorí), North Africa, Mediterranean; ④ Hittite Empire, Anatolia.

A large number of references show that the development and decline of those civilizations were closely related to the development, protection, utilization, loss, damage and destroy of local soil resource.

2.1 Aztecs and Mayan Empires

They developed some techniques of soil and water conservation (SWC) to increase agricultural yields and to adapt to their climatic and topographic conditions. There is no agreement on the reasons of their collapse. It is still a kind of mystery. In 1940s, S. Cook proposed the hypothesis of considering the soil exhaustion to explain the decline. Today, deforestation, erosion, forced population displacement and climatic considerations are gaining acceptance.

First, they used to slash and burn forests, then extensive terracing. More than climatic changes, we

have to consider the impact of droughts. The center terraces of the Mexico-Teotihuacan valley lie between 600 BC and 1000 AD. They used the traditional “milpa” system.

In the Mayas Lowlands, there were advanced water conservation systems and many terraces. Sediments shows two different episodes; the first correspond to forest clearing; the second to agriculture intensification, but it is only agricultural methods, including soil and water conservation, could not longer avoid erosion, and not sustain population, either.

Failures of their methods of soil conservation in deforested slopes are as below. Soil and water conservation systems were not adequate (not maintained) to avoid massive erosion and causing serious impact by sediment delivery to the agricultural areas in the valleys. Areas populated most densely in pre-conquest times had the worst exhaustion. Bench terraces is an old soil and water conservation system. It seems Phoenicians made the first bench terraces probably in fifteenth century BC.

2.2 The Inca Empire

The Inca Empire developed an outstanding and elaborated system of keeping productive soil in place in a very complicated and challenging environment. High and varied agricultural yields could be obtained under a complex social communal system. However previous to the Spanish conquest, the empire was in declining owing to civil wars and demographic recession. Atahualpa reached the throne after a devastating civil war against his brother Huascar.

There were many traditional Andenes (which is the traditional Spanish name for bench terraces in South America) system in Perú. The social and political instability trigger the gradual abandon of the use and maintenance of Andenes. The abandon of Andenes, under a complex communal system, was a factor contributing to the fall of the Inca empire. In this case, it was fighting a losing battle for the technical and social effort of heroic measures to save their soil.

2.3 The Indus Valley Harappa Civilization

Chris Sloan, an artist, reconstructed the gateway and drain at the city of Harappa. Lacking of capabilities on flood control for agricultural use, change on climate patterns, violence and disease played a key role in the collapse of the Harappa.

It was a civilization larger than Mesopotamia and Egypt. The reasons of the collapse are not clear and under general discussion. But recently, the the-

ory of changes in the climatic pattern along with difficulties in the control of sediments from Indus river and the maintenance of irrigation systems is gaining adepts. It was good developed in 5200 BC and collapsed 3 900~3 000 years ago.

It lacked of adaptation to a changing environment by adequate water-soil management. Initially flood supported farming in the Indus Valley, and allowed the development of agricultural surplus and the growth of Harappa's cities (rich soils). They did not develop irrigation capabilities relying on the summer monsoons floods. But the monsoons started kept shifting southward and became more erratic (increase of aridity) for adequate agricultural yields. The residents migrated eastward to the Ganges basin where they established smaller villages and isolated farms. The small surplus produced in these small communities did not allow development of trade, and the cities died out. The place at present is a barren country. Now, the climate is apparently the same as in ancient time, but the land is not.

2.4 The Fertile Crescent and Mesopotamia

The Fertile Crescent was a cradle of civilization, and also a permanent battle ground and one area always invaded and conquered by many civilizations, but it seems they did not collapse by that. It was mainly because the difficulties on the management of increasing sediments and the inadequate maintenance of their irrigation channels. The other crucial problem was the salinization of the soil.

Mesopotamia is a case of sediments and salt of the Fertile Crescent. Ur, ancient sea port is now 241.40 kilometers inland. Mesopotamian cuneiform clay tablets tell of crop damage due to salts and the earth is turning white.

The decline and collapse of the Fertile Crescent could be considered as a case of unrestrained down-load of sediments and a unrestrained increase of salt in their soils.

3 Discussion: Why Civilizations Collapsed?

There are many viewpoints on the causes of human civilizations development and decline, and scientists in different research areas made different explanations. It should be further explored, studied and verified. In our opinion, the following patterns and most repeated circumstances are their possible causes; ① strict dependence on rich land to rise; ② soil mismanagement; ③ soil resources depletion; ④ decline in agricultural yields; ⑤ instability and conflicts.

It would be better to take lessons from the past:

deepen into the root of the problem which basically seems to be linked between soil degradation and food security. There is an enormous amount and variety of theories to explain the collapse of civilizations.

The socio-economic points of view are as below: ① declining in productivity systems and economic activities; ② declining marginal returns; ③ catastrophes (earthquakes, climatic component ...); ④ insufficient response to circumstances; ⑤ intruders, conquerors; ⑥ chance concatenation of events; ⑦ social dysfunctions ...; ⑧ little consideration to "land resources depletion".

However as for the "declining marginal returns" theory, historians do not agree on the specific reasons of the fall of civilizations.

There are some enlightening references on "erosion of civilizations": ① Several writers have documented the decline of civilizations throughout history in parallel with the destruction of their soil. For example, Edward Hyams described people as "parasites" of the soil in *Soil and Civilization* (1952). ② Already in the first AD, Collumela wrote that "soil will retain its fertility indefinitely if properly cared for and frequently manured". All of them contributed with significant thoughts, reflections and conceptual developments to the historical role of soil conservation in human history and its influence in the rise and fall of civilizations.

The link between "climate changes" and the collapse of civilizations is not well supported; Severe drought affected the Late Bronze Age; Empires seems to have being a factor influencing the decline of Egyptian, Mycenaean, Hittites, Indus Valley and the Crescent Fertile civilizations; They had not the capability of land management to adapt a changing conditions. They lacked the necessary reactions. Sometimes, they acted too little, or too late.

The flourishing of civilization about 10 000 ~ 7 000 years ago, critically depended on stabilization of climate conditions. Egyptian, Mesopotamian and Indus civilizations about 4 200 years ago declined due to severe drought (Bronze Age). However more than "climate change", which basically remained the same, the fundamental factor seems to be the misuse of the land.

Many ancient civilizations mined soil and accelerated soil erosion well beyond the pace of soil formation and soil capacity to sustain life. We can say that man has succeeded into increasing locally and temporarily the productivity of soil, but in general and until now has failed to develop a real sustainable land management. History tells us that management and conservation of the land has given life expectancy of civilizations. As Jared Diamond described in his book

Collapse, societies choose to fail or survive. Such problems are not just ancient history. Recent historical great catastrophes are; Dust Bowl in 1930s and Droughts of Sahel in 1970s. We know now all the facts by which the soil is destroyed, but are modern world going to suffer the same fate?

4 Conclusions

All classes of land worldwide require some type of transformation so as to obtain some adaptations for agriculture use. It can be some type of terracing, leveling, runoff control, irrigation, contour leveling, etc. When the users of these measures abandon their maintenance, a declining trend could start leading to degradation processes and to the declining of productivity.

Scientists do not agree on the reasons of the collapse of civilizations. Little consideration has been taken to the effects of soil mismanagement and land resources depletion. However history reveals soil and water conservation is crucial to the permanence of any civilizations. The management and conservation of the land has shaped human history.

Today we confront a climate change, increasing land degradation and shrinking land available for food production. Considering the dimension and perspectives of present world problems, history tells us that we cannot ignore, not repeat mistakes of the past, including errors on soil and water conservation issues.

To keep and improve healthy living conditions for all mankind requires learning from the bad performances and incorrect assumptions of the past. We are more aware now of the likely consequences of our choices than any society in history. Would not it be embarrassing if we continued to make the wrong ones? Soil and water conservation has become a necessity for maintaining the sustainable development of social civilization. We cannot do little and too late.

This paper was presented at The Third World Conference of WASWAC, Belgrade, Serbia, August 2016. It is a tight summary of initial results of an international project (CIDE-Spain) on the interactions of soil degradation and the decline of civilizations. The references are omitted.

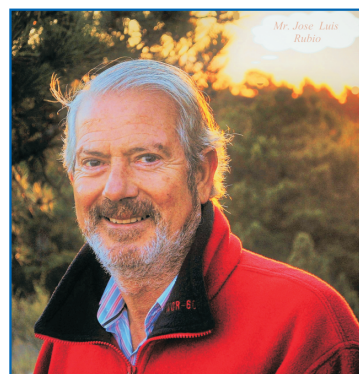


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专家论坛

国际著名水土保持研究专家

José Luis Rubio 先生论



水土保持对土壤安全和文明衰落的影响

水土资源的不当管理或滥用是影响土壤安全，进而导致人类文明衰落甚至毁灭的一个重要因素。本文系根据大量文献归纳而成的综述文章，旨在从世界历史上人与肥沃土壤的关系角度分析水土保持对土壤安全及文明衰落的影响。有关结论目前还主要是基于逻辑推理，而不是已知的事实。但是我们认为其基本的观点都是成立的，结论也合理正确。

1 土壤安全的威胁因素、作用及实现措施

对于土壤安全问题可以从国家、人类和环境安全角度分析，它指的是土壤在极端条件下生产粮食的能力和生态功能的降低，会威胁到土壤退化地区人们的生存。

(1) 土壤安全的概念包含5个方面：性能（土壤功能）、条件（土壤健康）、资本（货币和生态服务价值）、连通性（土壤的社会层面）和法规（政策和制度）。土壤安全涉及到包括环境、经济和社会等多个层面的议题。土壤安全是土壤退化的另一个层面，它影响着人类生存的基本条件。

(2) 威胁土壤生态安全的因素有：①严重的土壤及其肥力和多样性退化；②土壤调节和存储水分能力的下降；③气候影响及其变化（包括旱灾）以及人类的不当管理。所有这些因素都能造成作物欠收或减产，并进一步引起更严重、更长期的饥荒，使数亿人遭灾，甚至导致数以百万计人口的死亡。

(3) 土壤安全的影响包括：①提供维持人类生计的基本资源；②提供土地、居住地，技术知识和资源；③保证所有人口在所有时间获得足够数量和高质量的食物；④提供健康生活需要的营养丰富的食物。总之土壤安全影响人类的基本需求。如果没有以上土壤安全因素的作用，则会导致贫穷、饥饿、饥荒和社会政治的不稳定；或者为了争夺稀缺或退化的耕地而引发的冲突、暴力或战争；人口被迫迁移或移民；也会导致社会政治结构的衰败或崩溃。

(4) 实现土壤安全的措施主要包括以下两方面：
①应用适当的水土保持管理措施保护土壤肥力，遏制

土壤退化；②通过改善人类生活和健康条件，减弱土地退化的不利影响。

土壤安全就是指确保能够为人类提供良好的食物、生态服务的基本土壤资源，以满足人类健康生活的基本需求。

2 古代社会文明消亡的几个典型案例

历史上大约有10~30个不同古代文明衰落的案例，其中比较令人感兴趣且能说明问题的案例有4个：①印度河谷的哈拉帕文明；②美索不达米亚和亚州西部肥沃的新月形地带；③中美洲（奥克梅尔、玛雅、及查科文化），北非和地中海文明；④赫梯族人帝国的安纳托尼亚文明（今土耳其境内）。大量文献资料表明，这些文明的发展和衰亡都与当地土壤资源的开发、保护、利用、流失，破坏，甚至毁灭有着密切的联系。

2.1 阿兹特克人和玛雅人帝国

阿兹特克人和玛雅人当时发明了一些水土保持技术以增加农业产量和适应气候与地形条件。对于该文明衰落原因尚没有达成共识，至今依然是一个谜。19世纪40年代，S. Cook提出了考虑土壤耗减因素解释文明衰落的假说。现在人们逐步接受砍伐森林、土壤侵蚀，被迫移民和气候因素引起文明衰落的观点。开始阶段人们砍伐和烧毁森林，接着大面积修建梯田。关于该文明衰落的原因，相对于气候变化而言，我们应该更多考虑干旱因素的影响。墨西哥—特奥提瓦坎河谷中部梯田大约出现在公元前600年到公元1000年之间。他们采用的是中美洲传统的作物栽培体系（milpa）。

在玛雅人居住的谷地曾经有比较先进的水保护系统和大量梯田。调查结果表明，当地沉积的泥沙存在两个明显的发展阶段。第一阶段对应的是砍伐森林引起的土壤侵蚀；第二阶段对应的是农业活动加剧了侵蚀过程。尽管当时也采取了一些包括水土保持措施的农业技术，但是再也不能避免侵蚀，也不能维持人们的生计。

（上接封2）

他们的水土保持措施在毁林后坡地上的失败表现在如下几个方面：水土保持系统不足以防治（不是维持）大规模的侵蚀，导致大量的泥沙输移，对低谷地的农田产生了严重的影响。人口最密集地区在被征服以前已经处于最恶劣的资源枯竭状态了。条田是一种古老的水土保持体系，腓尼基人建造的最早的条田似乎是在公元前15世纪。

2.2 印加王国

印加王国（今秘鲁境内）开发了一套优秀而配套的技术使土壤在当地非常复杂又恶劣的环境条件下能够维持其生产力。他们能够在复杂的社会公共系统下获得高而不稳定的农业产量。但是在西班牙人征服印加王国之前该文明已在衰落，其原因在于内战和人口衰减。例如，印加帝国末代皇帝阿塔瓦尔帕在与其兄弟瓦斯卡尔的一场毁灭性的内战之后登上了王位的宝座。

古代秘鲁有很多传统的南美条田系统。社会和政治的不稳定导致人们逐渐放弃了对南美条田利用和维护。在一个复杂的公共系统内，南美条田弃用是影响印加王国衰落的一个重要因素。在这种情况下试图通过技术和社会努力挽救土壤的壮举注定是在打一场必败之仗。

2.3 印度河谷的哈拉帕文明

艺术家Chris Sloan重建了哈拉帕城市的供水和排水系统。农业利用中洪水调控能力的缺乏，气候类型的变化，暴力和疾病都在该文明衰落中起了关键的作用。

这里曾经是一个比美索不达米亚和埃及文明还要大的文明体制。关于其消亡的原因尚不清楚，仍然处在一般性的讨论之中。近来，随着对印度河泥沙控制和灌溉系统维护难题的研究，关于气候类型变化的理论获得了一些新的认识，并提出这个文明的良好发展阶段是在公元前5200年，消亡在3 900~3 000 a以前。

不合理的水土资源管理导致该文明古国缺乏对环境变化的适应能力。在印度河谷，最初靠洪水灌溉养育的农业为农业过剩和哈拉帕城市发展创造了条件。他们没有利用夏季风带来的洪水发展灌溉技术。但是，由于季风随后开始持续南移，并且变得反复无常（越来越干燥），不再适合农业生产。当地居民随后向东迁移至恒河流域，在那里建成小村庄和孤立的农场。当时在这些小聚落中生产仅有少量的盈余，不支持商业发展，因此城市消亡。该区如今已是一个贫瘠的地区，其气候明显与古代相同，而土地迥异。

2.4 美索不达米亚及新月沃土文明

新月沃土地带是文明的发祥地，也是被许多其他文明不断入侵和征服的战乱地区，但其似乎并没有因为这些战争、入侵和冲突而衰落。这主要是因为该区泥沙淤积不断增加，且灌溉渠道不足维系，难于管理。另一个关键的问题是土壤盐化。

美索不达米亚平原是新月沃土泥沙淤积和盐化的典型地区。乌尔城本来是一个古老的海港，其位置如今已深入内陆241.40 km。美索不达米亚的楔形文字泥板记录了该区的作物由于盐化而受损，土色变得越来越白的过程。新月沃土文明的衰落可以作为泥沙无限制淤积和土壤盐分无限制增加的一个案例。

3 讨论：古代文明衰落的原因

关于古代人类文明发展和衰落的原因有许多观点，且不同学科领域也有不同的解释，有待于对更多历史资料的进一步挖掘、研究与证实。我们认为，如下模式和反复出现的情景是这些文明衰落的可能原因：①其兴起高度依赖富饶的土地；②土壤管理不善；③土壤资源减少；④农业产量下降；⑤地区不稳定和社会冲突等。

我们最好汲取过去的教训，深入该问题的根源进行研究。他们归根到底似乎是土壤退化和食品安全的关系问题。有关文明衰落原因的理论很多，其相互之间差异也很大。

社会经济学观点认为这些文明衰落的主要原因如下：①生产力系统和经济活力下降；②最低赢利值降低；③灾害（例如地震、气候要素等）；④对环境变化的反应不足；⑤侵入者和占领者；⑥偶然事件的连锁反应；⑦社会功能失调；⑧对有关土壤资源减少考虑不足等。

关于“最低赢利值降低”理论，历史工作者至今未能达成共识。关于“文明的腐蚀”，有一些发人深省的著作阐述了这一问题。有几位作者在文献中记录了文明衰落及与其同期的土壤破坏情况的历史资料。例如，Edward Hyams 在其《土壤与文明》（1952出版）一书中将人类描述为土壤的寄生虫。早在公元第一世纪，Collumela 就写到“如果能得到适当的管护和频繁的施肥，土壤便可以无限期地保持其肥力”。所有这些文献都对关于土壤保持的历史作用，及其对文明兴衰影响的思考、反思与概念发展有重要贡献。

文明消亡与气候变化的关系在史料中没有得到很好的证明。严重的干旱对晚青铜器时代的农业及社会活动产生了很大影响。王国似乎一直是导致古埃及文明、古希腊迈西尼文明、赫梯人文明、印度河谷文明和新月沃土文明衰落的一个因素。他们没有适应条件变化的土地管理能力。他们经常缺乏应有的反应，有时候反应太小或太晚。10 000~7 000 a前文明的繁荣严重地依赖气候条件的稳定。大约4 200 a前的埃及、美索不达米亚和印度文明的衰落主要是由于严重的干旱（青铜器时代）。然而，这些文明衰落的根本因素似乎更应该是土地利用不合理，其作用超过了气候变化的影响。气候变化的影响也与此基本相同。

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(上接封3)

很多文明古国对土壤的开发利用和人为加速侵蚀速度彻底地超出了其成土的速度,也超出了土壤维持生命的能力。可以说,人类在某些地区或某些时候已经成功地提高了土壤生产力,但是在整体上,至今依然未能开发出一套可持续性的土壤管理方法。历史告诉我们,土地的管理和保护决定着文明的发展前景。正如Jared Diamond在他的《衰落》一书中描述的那样,“社会选择其自身的生存或消亡”。这些问题并不仅出现于古代历史中,近代历史上也出现了一些类似的大灾难。如19世纪30年代美国的干旱尘暴和70年代西非荒漠草原的干旱。我们已经了解目前所有毁坏土地资源的事实,难道当代世界还要遭遇与古代文明同样的厄运吗?

4 结论

在全球范围内,所有等级的土壤都需要通过采用某些方式进行改造,以使之适应农业利用。例如通过台田措施、水平阶措施、径流调控措施、灌溉措施、水平条田措施等等。当这些措施的使用者放弃维护时,土壤质量下降的趋势便会引起土壤退化过程,从而最终导致土地生产力降低。

关于古代文明的衰落原因,科学家们至今尚未达成共识。人们很少考虑土壤管理失误和土地资源耗减的影响。然而历史表明,水土保持对任何文明的可持续性都是至关重要的。正是对土地的管理和保护塑造了人类的历

史。目前,我们面临着气候变化,不断加剧的土地退化和可用于粮食生产的土地面积不断缩小等严重问题。针对当今世界现存问题的前景及范围,借鉴历史的沉痛教训,为了人类发展的美好前景,我们再也绝不能重复过去的错误,特别是不能再犯过去忽视水土保持问题的错误。

为了维护和改善人类健康生活的条件,我们需要从过去不良的行为和错误的认识中总结经验教训。我们现在应该更加清楚地意识到,当今的这种选择可能引起的后果比历史上任何社会都更为严重。如果我们继续坚持这种错误的生存方式,难道我们不会陷入窘境吗?因此,水土保持已经成为一种维系社会文明持续发展必不可少的事业,我们不能做的太少,更不能做得太晚!

本文根据 José Luis Rubio 先生于2016年8月在塞尔维亚首都贝尔格莱德召开的世界水土保持学会第三届国际水土保持学术研讨会的主旨报告整理和编译而成。原文为国际合作项目(CIDE-西班牙)“土壤退化与人类文明衰落相互作用研究”的简要总结。有关参考文献略。

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