Feng-shui – Ancient Geodesign as a Clue: Identifying Predictive Landform Models of Mountain Flood Impact Zones

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Abstract: The 2013 historical flood in the Colorado Front Range revealed the problems of siting processes. Homes built in debris/mudflow impact zones demonstrate the lack of knowledge and limited warning systems concerning such hazards. The mountain floods, including debris/mudflows and post-fire factors, have not been researched sufficiently in site planning efforts. In contrast, some vernacular siting methods, such as *feng-shui,* would provide wisdom. *Feng-shui* is an ancient Chinese practice used to harmonize people with their environment; in particular, the form school provides landform criteria of mountains, hills, water, site, and orientation, to identify good luck sites and risk areas. *Feng-shui* is an ancient geodesign. Using geomorphic knowledge and *feng-shui* as a clue, the author's field investigations were carried out in the canyons of the Colorado Front Range for four months. This research identifies four landform models: (1) the Basin Model, (2) the Distant Model, (3) the Local Model, and (4) the Combined Model. By testing them with the information of the 2013 Colorado flood data, the four models will be valuable for predicting the debris/mudflow high impact zones physically or digitally. This interdisciplinary research could benefit site selection processes, planning efforts, and mitigation strategies in order to avoid building in risk areas and to evacuate during natural hazards in the Colorado Mountains and beyond.

Keywords: Feng-shui, ancient geodesign, debris/mudflow, landform models, impact zones, dry wash

1 Introduction

1.1 Debris/Mudflow is the Key Issue

From September 9th to the 15th, 2013, heavy rain over complex mountain terrain with steep landforms caused a historic flood along the Colorado Front Range, USA. The violent power of the flood destroyed homes, roads, and bridges, wiped out small towns, rerouted creeks and streams, and took lives. The flood impact areas revealed the problems of the practice and education on site selections for mountain properties. Scientific knowledge is only superficially considered in site planning efforts. The mountain floods, including debris flows, mudflows, landslides, and post-fire factors, have not been researched sufficiently. Shocked by the 2013 flood impacts on her mountain neighborhood at Boulder, the author has been seeking solutions. This research emphasizes the debris/mudflow and its high impact zones in the canyons of the Colorado Front Range.

A debris/mudflow is one of the most dangerous natural hazards (COSTA 1987). A debris flow begins with a dense mud and stone flow, then it increases its solid concentration and size when proceeding downstream, and finally it develops into a full debris flow (TAKAHASHI 1991). During intense and heavy rain, a debris/mudflow comes with great power from a higher elevation. It can climb several feet and knock out houses. Debris/mudflow impact areas are often not mapped in the zone of the known floodplain. There are major and minor debris flows. Major debris flows have often been recognized and mitigated by scientists and

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local governments (LI 2004). While minor debris flows typically occur from local hills, they can still cause deadly disasters.

1.2 Hypothesis and Method

The debris/mudflow can be violent, a deadly natural disaster. It is crucial to predict high impact areas. The hypothesis of this research is that the landform patterns of the debris/mudflow's originating area, developing area and high impact area can be identified, described and mapped; and the high impact area can be predicted by identifying the landform patterns. The research method includes following components: 1) Geomorphic study on debris/mudflows; 2) Research on ancient feng-shui textbooks of site selection practices; 3) Field investigations, using geomorphic concepts and feng-shui as a clue to identify the landform patterns; 4) Creating predictive landform models that would be valuable for predicting the debris/mudflow high impact zones physically or digitally; and 5) Testing the predictive models with the information of the 2013 Colorado flood data.

2 Feng-shui – Ancient Geodesign

In contrast to contemporary site analysis practices that lack knowledge of mountain floods, some vernacular siting methods can provide wisdom. Adaptations to natural laws are directed towards enhancing life by promoting harmony between humans and nature (MCHARG 1971). China has a long tradition of recording debris/mudflows that have killed up to thousands of people (LI 2004). Thirty percent of the Chinese population lives in mountain areas and two-fifths of the cultivated land is located in mountain regions of the country. China's survival experiences for thousands of years are primarily summarized in *feng-shui* practice. Feng-shui, 堪輿術 – Chinese geomancy, an ancient Chinese practice used to harmonize people with their environment between Heaven and Earth. Feng-shui is practiced to select good timing, a suitable place, and supportive partners in order to sustain people's lives and their societies. Feng-shui has many schools; particularly prominent is the form school, which deals with landforms such as mountains (龙), hills (砂), water (水), site (穴), and orientation (向), in order to select favorable sites and avoid disaster.

Fig. 1:
A late Qing Dynasty illustration of the practice in town site selection, which is an excellent example showing the feng-shui approach (EITEL 1873). Corresponding to the geodesign concept, the official is leading a group: a *feng-shui* master consulting his compass, another checking the *feng-shui* manual, and the workers analyzing the soil and water, applying ancient geographic knowledge. Different from contemporary geodesign that utilizes digital media; feng-shui technique was limited by its time. Feng-shui is the ancient Chinese Geodesign. As Carl Steinitz states, "geodesign is

not new." Geodesign is a practice in which the people of the place, design professionals, geographic sciences and information technologies cooperate (STEINITZ 2012).

The author's early research on feng-shui is her doctoral dissertation at Harvard University, using an early version of GIS (Geographic Information System). By comparing feng-shui with a conventional Western method of landscape planning, she demonstrated feng-shui as a valid alternative method for landscape analysis. Feng-shui practices with multiple scales, from large to small; and emphasizes the horizontal and spatial analysis (XU 1990). More importantly, feng-shui presents an ancient way of systems thinking, integrating all information together, natural and human. Systems Philosophy has roots in ancient thought (LASZLO 1972). Feng-shui is not only a valid practice, but also contributes to exploring an integrative approach to contemporary geodesign.

3 Field Investigations

3.1 Areas of Field Investigations

The historic 2013 floods provided a unique opportunity to research mountain floods. The author's field investigations were carried out for about four months in the canyons along the Colorado Front Range, from mountain valleys to single sites of high impact areas, and included interviews with local residents. Using *feng-shui* as a clue, the author identified landform patterns of the debris/mudflow's original area, developing area and high impact area, and compared them with geomorphic knowledge.

Fig. 2:
The high impact areas investigated in the Canyons of the Front Range, Colorado, USA. (1) Chapel on the Rock; (2) James Canyon, Jamestown; (3) Big Thompson Canyon, Drake; (4) west end of Arapahoe Ave. Boulder; (5) Poudre Canyon, Poudre Park; (6) Big Elk Meadow Drive, Lyons; (7) sites at Olde Stage Road; and (8) sites at North Cedar Brook Road, Boulder.

The field investigations indicate that the high-impact zones always involved debris/mudflows. The characteristics of the bedrocks and soil in the Rocky Mountains provide abundant debris – the bedrocks are often exposed, the soil is thin, and roots grow shallow, causing trees to fall easily. Mountain fires frequently occur. During intense and heavy rain, debris/mudflows are common occurrences in the canyons of the Colorado Front Range.

3.2 Identifying Landforms in Light of Feng-shui

To predict hazard impact zones, feng-shui practice examines landforms of mountains, canyons, hills, water, and site. This ancient method demonstrates a systematic process by identifying landforms of 1) the input zone – providing debris source; 2) the developing zone of debris/mudflows – flow track; and 3) the output zone – the impact area. As Lazlo suggested, we should find out what is meant by "system" and how systems are realized at the various

levels (LASZLO 1972). However, current mitigation often emphasizes engineering solutions on the impact receiving zones to solve the problem, rather than making strategies to manage the catchment areas and the flow track.

1) Landforms of the input zone – providing debris source

The first step of a feng-shui field investigation is to figure out where the "dragon" comes from and judge the nature of the "dragon." The "dragon" refers to a mountain range and canyons. The unfavorable dragons include the "sick dragon" – the mountain surface is broken, forming a basin area; the "violent dragon" – a narrow and dark canyon that has steep slopes and many broken rocks and rolling stones; the "ominous dragon" – the canyon plan takes the shape of zigzags; and the "dead eel" mountain – the mountain has a straight ridge (XU 1580, QIU 1995) (Figure 3). In the author's field observations, all such canyons and mountains provided abundant debris sources, a crucial precondition for debris/mudflows.

Feng-shui warns people not to build on "crab leg" hills with a zigzag plan view, "broken flag" hills full of debris and broken rocks, or "hills without veins" that have steep and less rugged gradients (JIANG 1997). The smooth and steep hillside can cause flooding with heavy rainfall (LIU 1986). The author's field investigations indicate that the slopes generating debris/mudflows are between 25 % – 45 %.

2) Developing zone of debris/mudflow – flow track

Feng-shui practice pays special attention to the forms of water bodies. The feng-shui warning is against building on an "outside downstream corner" where the water flow changes direction sharply, which is called the "water shooting heart." A dry wash can generate powerful debris/mudflows during intense periods of heavy rainfall. Such debris/mudflows are called "water showering head," one of the most evil disasters (YE 1688). A dry wash or gully, with a narrow and straight channel, is called "hidden arrow," which functions as a debris mudflow track (ZOU 1676) (Figure 4).

Fig. 3 (left)**:**
Feng-shui diagrams of unfavorable mountains (source: XU SHIKE 1580, Di Li Tian Ji Hui Yuan, Chapter 5)

Fig. 4 (right)**:**
Feng-shui diagrams of unfavorable types of water (source: YE JIUSHENG 1688, Di Li Da Cheng, Chapter 4)

3) Output zone – impact area

Once the debris/mudflow meets a point where the slope suddenly drops more than 20 %, the debris/mudflow becomes a fast flow with a straight channel and shoots the debris onto the plain of an impact area with a slope less than 10%. *Feng-shui* men often favor a confluence

area for a house site, but the author's field investigations indicate that the confluence area at the lower portion of a canyon can be a high-impact zone of debris/mudflows.

4 Four Models: Comparing Feng-shui Evaluations with Geomorphic Knowledge

Comparing geomorphic knowledge with the vernacular practice of feng-shui, this research identifies four landform models predicting debris/mudflow impact zones in mountainous areas: (1) the Basin Model, (2) the Distant Model, (3) the Local Model, and (4) the Combined Model. These four models are described with landform patterns including landforms providing abundant debris sources – catchment areas, landforms generating the speed and power of debris flows – flow track, and landforms of areas receiving debris flows – debris flow fan. The geomorphic concept and terms used here refer to research articles on debris/mudflows (ONDA 2004, CLARK 1987, RENEAU & DIETRICH 1987).

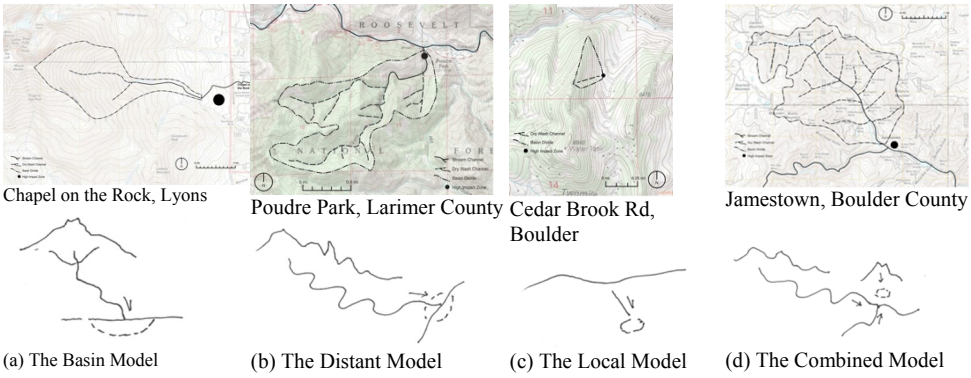

Fig. 5: Maps and diagrams of four landform models are described with the catchment area, the flow track, and the impact area – debris flow fan

1) The Basin Model

A dry wash or small creek originates from a basin near mountain peaks. The basin is rich in debris. Such a mountain in the feng-shui practice is called "the sick dragon." The hillside where the dry wash passes through has a constant slope of 35 % – 45 %. During intense and heavy rains, the debris with runoff is washed into the narrow flow track, and generates the violent power as proceeding downstream. When meeting a point where the slope suddenly drops more than 20 %, the debris/mudflow shoots and releases the debris onto the impact area, which has about a 5-10 % slope. The debris released can be over 10 feet high (Figure 5-a). The geomorphic research demonstrates that two-thirds of failures initiate within the basin. Therefore an emphasis on both the basin and the flow tracks from upslope is significant in identifying the hazard (RENEAU & DIETRICH 1987).

In the canyons of the Colorado Front Range, there are several cases representing the Basin Model. The site of Chapel on the Rock was heavily impacted by the 2013 debris/mudflow coming from Mt Meeker, 5 miles away (Figure 5a). Mt Meeker has a great basin above the tree line, which provides a rich debris source. The debris/mudflow buried roads in a layer of mud and tree chips over 100 feet wide and 6 feet high. Similarly, another site in the city of

Boulder, located on the lower plain of the Flatiron Summit Basin, acts as a receiving area for debris/mudflows. During the 2013 floods, the debris/mudflow split a building into two parts and over ten feet of mud filled the first floor and the parking lot.

2) The Distant Model
A dry wash or small creek originates from over seven miles away (Figure 5-b). It passes through the canyons taking a zigzag shape. The hillsides have a 25 % – 35 % slope. In *feng-shui* practice, such canyon is evaluated as a "violent dragon" with "crab leg hills." The huge catchment area with steep slopes provides rich debris sources. With enough runoff, the narrow flow track generates a powerful debris/mudflow that can climb the bank and knock down structures at the plain, which has a slope less than 10 %.

Examples of the Distant Model are cases like Jamestown, Drake, and Poudre Park, which saw heavy impacts requiring evacuation during the 2013 floods. In Jamestown, many houses were flooded and a death resulted. A large house had a third of its structure knocked down and others were destroyed completely. The site at Drake is located in a confluence area having a 6 % slope. Eight houses were flooded by the debris flow, which spread mud over four feet high. Poudre Park, located on a confluence area with a 10 % slope, recently experienced debris/mud flows after mountain fires (Figure 5b).

3) The Local Model
A gully, swale, or dry wash is located on a straight ridge hill, a "dead eel hill" in *feng-shui* terms. This hillside has a 35-45 % slope with a constant gradient. *Feng-shui* states that a smooth hillside can cause floods. The narrow straight channel of the dry wash, a "hidden arrow", can initiate a "water showering head" debris/mudflow with heavy rainfall. When the slope drops over 20 %, the debris/mudflow directly releases debris and mud onto the impact area. The author's field investigations show that such debris/mudflow often damages buildings within an acre land. The debris/mudflow is at a local scale, but it can have a deadly impact. Geomorphic research indicates that debris/mudflows, generated from small tributaries, dry washes, swales, and from side slopes, are also destructive (RENEAU & DIETRICH 1987).

Examples of the Local Model are cases like Three Lakes, Olde Stage, and Cedar Brook Rd, which observed high impacts during the 2013 floods. The lakes at Three Lakes filled with mud; many houses built on the lower portion of the hills or by the lake were in the receiving zone of the debris/mudflows; and a house on hillside was destroyed. North of Boulder there are straight ridge hills running north to south. Located in the valley and by North Cedar Brook Road, a house built on the hillside facing east was demolished by a debris/mudflow, and part of the upper floor fell into the basement (Figure 5c).

4) The Combined Model
Combined criteria for a high-impact site are rarely found in feng-shui textbooks. The author's field investigations indicate that the high-risk areas of the 2013 floods present similar combined landform patterns. The combined model can be described as followings: 1) the site, having a slope < 10 % and located at a confluence area of the lower portion of a canyon, forms a receiving zone for a debris/mudflow; 2) a small creek, originating from several miles away, flows down to the site through a "violent" or "ominous" canyon taking a zigzag shape; 3) the hillsides have a 25 % – 35 % slope; 4) the narrow channel of the creek can combine water, mud, sand, rocks, and dead trees, into a powerful debris/mudflow; 5) a river directly pointing at the site, which is called the "water shooting heart," can have the power to destroy

homes; and 6) a steep hill north of the site had experienced fires within a few years of the flood, leaving unstable soil and dead trees, these deposits developed into a local debris/mudflow that hit the site and fed into the river during intense and heavy rain. In combination, these landform conditions led to the heaviest impacts in Jamestown and Drake during the 2013 Colorado mountain floods (Figure 5d).

Orientation

Feng-shui practice emphasizes selecting orientation as part of site selection procedure. According to XU's field investigations, the debris flow events occur in the canyons open to the north, east, and southeast. The local debris/mudflows occur on the slopes facing north, east, and southwest. Other research documented the debris flow dominating the slopes facing the northwest, north, northeast, and east. These slopes are shielded from direct solar insulation, and retain higher soil moisture levels from periods of rainfall (CLARK 1987).

Postfire Issue

Debris flows following mountain fires are common, but rarely researched (WELLS 1987). In canyons of Colorado Front Range every high-impact zone had experienced a fire before the flooding, most occurring within two years. The fire burns vegetation from the mountainsides, killing the groundcover and loosening debris. After two years even the roots have died. During heavy rain, the dead trees fall more easily, levering out the soil and producing debris. Geomorphic research indicates that in the debris/mudflow, a large amount of heavy timber is substantial to causing landslides and destroying property (RENEAU & DIETRICH 1987). Cutting down the burned trees on slopes might reduce the dangerous impact. Current geomorphic research also states that in mountainous areas the clusters of landslide debris that partially or completely block sloping channels can cause debris flows (CUI 2013).

5 Conclusions

The significant correspondence of feng-shui criteria to geomorphic concepts indicates that feng-shui is not only a valid method, but can also expand our knowledge of site selection to establish mitigation strategies against natural hazards. Moreover, feng-shui practice emphasizes horizontal-spatial analysis of landforms and their impacts, and integrates large and small scales. The debris source can be miles away from the impact site. Working on a small scale, one may miss impacts at a large scale. This would explain why the 2013 debris/mudflows shocked the planners as well as the general public.

As an ancient practice, feng-shui certainly has its limits. First, feng-shui criteria had primarily based on the experiences of practices in China, particularly in the northern regions. When dealing with different geographic and climatic conditions, feng-shui criteria need adjustments (XU 1990). Feng-shui criteria can be used as clues, hypotheses, or references to identify landform patterns or natural disaster issues. It would be risky to practice feng-shui without understanding of the principles of design and planning. Besides misinterpretations of feng-shui, those pseudo geomancers have always been a major problem in this trade, even in the ancient times of China. Thus, landscape designers and planners would play a significant role in exploring a new approach combining feng-shui method with contemporary landscape design and planning.

In this research, feng-shui principles are used as a clue, alongside a comparison of geomorphic knowledge, to identify the landform patterns and models. This approach would enrich the methods of geodesign by integrating vernacular experiences with contemporary site

selection processes. The key method of research aimed at predictive models is field investigation. It has significant meaning, particularly for today's computer era, during which virtual distance creates a separation from the physical world. Visiting a site – seeing the landscape and understanding the spatial relationships of the landforms – is integral to practice and education.

By comparing feng-shui field evaluations with geomorphic concepts, this research identifies four landform models: (1) the Basin Model, (2) the Distant Model, (3) the Local Model, and (4) the Combined Model. These four models are described with an emphasis on both the basin and the flow track of a dry wash, small creek or gully from steep upslope. In addition, debris/mud flows following mountain fires are common in the investigated areas. By testing them with the information of the 2013 Colorado flood data, the four models will be valuable for predicting the debris/mudflow high impact zones physically or digitally. This interdisciplinary research could benefit site selection processes, planning efforts, and mitigation strategies in order to avoid building in risk areas and to evacuate during natural hazards in the Colorado Mountains and beyond.

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