

The "Xiang-Wu-Tian-Di" Spatial Model and the Theory of Landscape Livable Cities in China: A Case Study of Panzhihua

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ABSTRACT

This study examines Panzhihua, a traditional resource-based city in Sichuan Province undergoing a remarkable metamorphosis from an industrial hub to a landscape-oriented livable city. Confronting the dual challenges of ecological preservation and urban development inherent to its canyon geography, the research innovatively integrates China's ancient urban planning wisdom of Xiang-Wu-Tian-Di (Image-Object-Heaven-Earth) with cutting-edge technologies such as drone mapping and 3D modeling. By transforming philosophical principles into actionable urban planning solutions, the study establishes a sustainable development paradigm characterized by cultural continuity with humanistic warmth, ecological restoration with technical precision, and industrial transformation with strategic foresight. This approach not only revitalizes Panzhihua's urban fabric but also serves as a replicable blueprint for similar cities navigating the complex interplay of heritage conservation and modernization.

Keywords: *Xiang-Wu-Tian-Di (Image-Object-Heaven-Earth), Spatial model, Landscape livable city, Panzhihua, Dry-hot valley.*

1. INTRODUCTION

Panzhihua, a quintessential mountainous city that marries a distinctive mountain-water topography with industrial urban characteristics, confronts multifaceted challenges in balancing ecological conservation, spatial expansion, and livability enhancement. Against this backdrop, integrating China's traditional Xiang-Wu-Tian-Di (Image-Object-Heaven-Earth) spatial philosophy with modern urban planning theories holds profound theoretical and practical significance for forging pathways toward a landscape-integrated livable city.

Professor Zhang Jie of Tsinghua University conceptualized the Xiang-Wu-Tian-Di framework, which prioritizes four dimensions: Xiang (perception of natural forms), Wu (construction of material spaces), Tian (alignment with climatic rhythms), and Di (adaptation to geological conditions). This paradigm establishes a spatial order of harmony among heaven, earth, and humanity, offering a philosophical foundation for

mountainous urban planning. Building upon this, Dong Xiaoli's research on ecological adaptability in mountain towns advances strategies to organically integrate terrain with urban functions through "terrain-responsive shaping and water-guided structuring." Parallel to these, Qian Xuesen's "Landscape Garden City" vision and Wu Liangyong's "Landscape City" theory advocate blending natural and built environments to achieve "city-scene symbiosis." Collectively, these theories empower Panzhihua to transcend the extensive expansion model of traditional industrial cities and transition toward ecologically oriented sustainable development.

Despite progress in ecological restoration, such as the Jinsha River green corridor and mine rehabilitation, gaps remain in translating cultural symbols (Xiang-Wu interaction) and climate-responsive design (Tian-Di synergy). This study aims to bridge traditional wisdom and modern technology, developing an operational "Xiang-Wu-Tian-Di" spatial model for Panzhihua to advance

landscape livable city theory and provide a reference for similar mountainous cities.

2. THE PHILOSOPHICAL CONNOTATION OF THE "XIANG-WU-TIAN-DI" SPATIAL MODEL IN PANZHIHUA

Chinese urban construction has long emphasized a spatiotemporal dialogue of harmony between humanity and nature, with the wisdom of Xiang-Wu-Tian-Di (Image-Object-Heaven-Earth) deeply rooted in the philosophical tradition of "unity of heaven and humanity." Ancient texts such as Zhouli·Kaogongji (Rites of Zhou: Artificers' Records) laid the foundation for adaptive urban planning through principles like "determining orientation and positioning, structuring the state, and organizing the wilderness." The Song Dynasty's Yingzao Fashi (Treatise on Architectural Methods) further articulated the interplay between natural and artificial elements via a trilogy of "capturing terrain, establishing foundations, and defining forms." By the Ming Dynasty, Ji Cheng's Yuan Ye (The Craft of Gardens) elevated this philosophy with the concept of "artificial creations mirroring nature's spontaneity," forming a holistic human settlement system.

Professor Zhang Jie of Tsinghua University has reimagined this tradition in a modern context, refining Xiang-Wu-Tian-Di into a four-dimensional spatial cognition framework. In Panzhihua's Jinsha River dry-hot valley, this framework merges digital modeling and ecological engineering to revitalize millennia-old wisdom. This study deciphers Panzhihua's urban spatial dialectics through the lenses of Xiang, Wu, Tian, and Di:

2.1 Xiang: Decoding Natural Forms

Amid Panzhihua's layered peaks, Xiang manifests as a profound interpretation of natural landscapes. Drone oblique photogrammetry and 3D laser scanning construct a digital twin model of the Jinsha River canyon, precisely mapping its "three mountains flanking two rivers" spatial pattern. Research reveals that aligning the urban axis at a 15° offset from mountain ridges not only follows geological fault lines but also optimizes solar exposure—a digital reinterpretation of the ancient milong chasha (geomancy-based site selection) wisdom.

2.2 Wu: Vertical Spatial Revolution

Confronting slopes exceeding 25% (47% of land), Wu drives a vertical spatial transformation. In the Nongnongping District renewal plan, a "terrace clusters + three-dimensional transport" model creates seven elevation platforms connected by spiral ramps and elevators. Industrial heritage is reimagined: the 30-meter truss structure of Panzhihua Steel's old factory becomes an aerial viewing corridor, merging industrial memory with panoramic landscapes.

2.3 Tian: Climate Adaptation

To combat the valley's summer extremes (42°C), Tian inspires a microclimate regulation system. Three 45-meter-wide ventilation corridors along the Jinsha River, with a 1:1.5 building-height-to-width ratio, amplify airflow penetration by 300%. In Bingcaogang, ceramic sunshades with seasonally adaptive porosity (65% winter transmittance, 30% summer) reduce annual cooling energy consumption by 40%.

2.4 Di: Geohazard Resilience

In this seismically active canyon, Di shapes an intelligent disaster prevention system. Millimeter-level landslide early warnings are enabled by slope displacement monitoring. At Guaziping, a "micro-piles + vine reinforcement" technique combines concrete piles with *Mucuna sempervirens* vegetation, cutting maintenance costs by 60% compared to conventional methods. Underground, abandoned mines are repurposed into energy storage facilities, alleviating land scarcity and balancing power grids.

Panzhihua's practice transforms traditional spatial philosophy into a four-dimensional dynamic evaluation system, epitomizing the modern essence of "Xiang-Wu interaction and Tian-Di symbiosis." By converting feng shui principles into GIS algorithms, this approach extends Dong Xiaoli's "3D synergy" theory and addresses technical gaps in Wu Liangyong's landscape city concept. The result is a culturally rich yet technically precise Chinese solution for mountainous urban renewal, harmonizing heritage preservation with cutting-edge innovation.

3. CONSTRUCTING THE "XIANG-WU-TIAN-DI" MODEL FOR PANZHIHUA

3.1 *Four-Dimensional Coupling Mechanism: Digitally Empowered Spatial Algorithms*

Within the folds of the Jinsha River Grand Canyon, the "Xiang-Wu-Tian-Di" (Image-Object-Heaven-Earth) model operates as a precision spatial algorithm. Twelve drones equipped with LiDAR conducted a comprehensive scan, constructing a 5-cm-resolution digital twin of the canyon's terrain. This model meticulously reconstructs 52 mountain ridge trajectories and three abrupt river bends, functioning like a "geological CT scan" that reveals hidden basalt columnar joint zones in the Bingcaogang area—providing natural coordinates for spatial planning.

By overlaying GIS data on ecological sensitivity and engineering geology, a "red-yellow-green" development intensity zoning system was established. In the Nongnongping District: Red zones (slopes >35%) are transformed into cliff-mounted photovoltaic arrays; Yellow buffer zones host terraced communities adapted to intermediate slopes; Green buildable areas employ an innovative "stilted architecture" model, reducing excavation volumes by 75%.

ENVI-met simulations demonstrate that creating 45-meter-wide, NE-SW-oriented ventilation corridors along the Jinsha River can reduce summer urban heat island intensity by 2.8°C, extending cooling airflow penetration from 300 meters to 900 meters. Concurrently, synthetic aperture radar (SAR) monitoring identified eight landslide-prone areas with annual displacements exceeding 15 mm, enabling targeted risk mitigation.

3.2 *Spatial Gene Decoding: Industrial Aesthetics Reimagined*

The spatial code of Panzhihua lies in the dialogue between steel and red earth. Through a "spatial dissection" of 32 Third Front Movement industrial relics, 23 characteristic design genes were extracted, including the arched structures of mine tunnels, cylindrical forms of steelmaking furnaces, and linear textures of ore transport tracks.

In the transformation of the 502 Power Plant, the 8-meter-diameter condenser shell was preserved, with a suspended glass observation deck installed

inside. The exterior, now draped in bougainvillea, blossoms into a "steel flower basket," poetically revitalizing industrial ruins.

Drawing inspiration from the sedimentary stratifications of Gesala, parametric design translates rock layer textures into architectural facade modules. This approach harmonizes functional daylight optimization with morphological storytelling, merging pragmatic needs with aesthetic narrative.

4. CONCLUSION

This study integrates China's traditional "Xiang-Wu-Tian-Di" (Image-Object-Heaven-Earth) spatial model with modern urban planning theories in Panzhihua, proposing a livable city framework rooted in Chinese philosophical principles that challenges the Western-dominated urban planning paradigm. Leveraging Panzhihua's unique mountainous terrain, climatic conditions, and multicultural context, the research explores the adaptive application of the "Xiang-Wu-Tian-Di" model in southwestern mountainous cities, addressing gaps in traditional theory's regional implementation. By anchoring the "Xiang-Wu-Tian-Di" framework, a dynamically balanced "mountain-water-city-human" livable spatial system is constructed, emphasizing interactive feedback mechanisms between urban development and the natural environment. Distinct from Western "Garden City" or "Pastoral City" concepts, the study advances a "Landscape Livable City" paradigm grounded in Chinese landscape aesthetics and philosophical logic, highlighting localized values of "harmonious integration of topography and human settlements." Through macro-, meso-, and micro-scale spatial strategies, the research establishes systematic planning methodologies to operationalize the "Xiang-Wu-Tian-Di" model, offering a culturally resonant and technically robust approach to sustainable urbanization.

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