

SUSTAINABLE PERI-URBAN RESIDENTIAL SETTLEMENT DEVELOPMENT IN CHINA: EVALUATION OF THREE CASES IN TIANJIN

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ABSTRACT

Fuelled by rapid urbanization, urban spatial expansion is increasingly encroaching on the rural hinterland of large metropolises in developing countries. Peri-urban residential settlement development in Chinese cities has seen unprecedented rate in recent years, however, its current situation and implications for sustainability are little understood. The purpose of this paper is to understand through empirical findings the current situation of peri-urban residential settlement development in a Chinese city and examine their progress against the requirements of the sustainable development agenda. In this paper, three recent development cases located in the city periphery of Tianjin, China are studied and a theme-based evaluation framework is used to examine their outcomes. Their specific approaches to achieving sustainable development are discussed, and emerging problems and challenges are identified and analysed with suggestions for the complementary approaches and progression in the planning and management of peri-urban settlements.

Keywords: China, peri-urban, settlement development, sustainability.

1 INTRODUCTION

The world is rapidly urbanizing with the developing world being the main contributor to this process. Spatial expansion of growing cities increasingly encroaches on their rural hinterland, making a type of spatiality referred to as the ‘peri-urban’ an important focal point for urban studies. Since the 1980s, urban planning in China has favoured ‘decentralized concentration’ growth management policies, which encouraged the development of planned peripheral settlements and the building up of the peri-urban interface around all Chinese metropolitan regions [1]. In recent years, fused by urban population and economic growth, peri-urban settlements in Chinese cities are undergoing rapid development, which is often characterized by the building of large-scale and high-density peripheral gated residential estates. The peri-urban interface is undergoing huge environmental, social and economic transformations. Yet, its current situation is little documented and the implications for sustainability are not well understood. This paper seeks to fill this gap by providing a more up-to-date documentation of peri-urban settlement development in the Chinese city of Tianjin and presenting the current and emerging challenges that face sustainable peri-urban development.

Since China’s Agenda 21 was published in 1992, sustainable development has been accorded national strategy, which proposes the integration of the social, economic and environmental goals of society. Being interlinked with both the urban and the rural sectors, the peri-urban interface witnesses the interwoven issues of agricultural land, ecological system, employment and well-being, which affect the sustainable development of both sectors. To understand sustainability in this context requires enquiry into its environmental, social and economic dimensions, as well as benefiting both the urban and the rural contexts. The paper explains the peri-urban dynamics in the Chinese context and discusses three recently planned and developed peri-urban residential settlement cases in the metropolitan area of Tianjin, all of which lay claim to certain facets of sustainability. An analysis is carried out on the study cases using a proposed theme-based sustainability evaluation framework.

Based on the empirical findings, current and emerging challenges to sustainability are discussed and suggestions for the complementary approaches and progression in the planning and management of peri-urban settlements are proposed.

2 PERI-URBANIZATION IN CHINESE CITIES

Peri-urbanization refers to the process in which rural areas located on the outskirts of established cities become more urban in character, in physical, economic and social terms [2]. China has embarked on a fast track of peri-urbanization since the early 1980s, when economic reforms diverted policy towards encouragement of rural industrialization and urbanization. In recent years, the negative impacts of increased decentralization of urban settlements were realized, with agricultural lands being converted to non-agricultural purposes at an unprecedented speed. With increased demand for new physical and social infrastructure provision, this not only causes considerable degradation of the rural environment but also exerts pressure on the existing supporting system of the city. Furthermore, the centrally led and often enforced, requisition of farmland has created millions of landless farmers. With their social security being previously exclusively derived from land ownership, landless farmers are often forced to relocate and are found to be vulnerable to impoverishment [3,4]. Since 2006, more strict restrictions have been enforced on non-agricultural development that requires the requisition of farmland. Innovative land use strategies were proposed nationwide to address the conflict between the loss of farmland and the need for rural urbanization. Among these, the 'Exchange *Zhaijidi* for Apartment' (EZA, *zhaijidi huanfang*) programme has gained most attention and support from the authorities. *Zhaijidi* is a piece of land that is collectively owned and granted to rural households to use as the site for their homes. The EZA programme allows a rural family to exchange *zhaijidi* for an apartment in a newly developed conglomerated residential compound. The rationale behind is that by opting for a more compact form of rural settlement, more land can be released for peri-urban development. The reclaimed *zhaijidi* will then be converted to agricultural land by means of re-cultivation, so as to compensate for the loss of farmland to non-agricultural developments. The EZA programme is now being experimented in a number of regions including Tianjin and Chongqing, with an aim to find a balance between requisition and re-cultivation of farmland and a way of *in-situ* resettlement of the rural community in the process of peri-urbanization.

In recent years, the development of suburban residential estates is exerting increasing influence on shaping the peri-urban interface of Chinese metropolitans. Peri-urban residential development has taken mostly two forms: affordable housing compounds associated with inner urban regeneration, and real estate development of suburban commercial housing estates.

Inner-city regeneration has largely contributed to peri-urban residential development. Compared to other developing countries, where the informal sector played a significant role in accommodating the displaced population, China took a centrally coordinated approach by building large-scale and high-density affordable housing estates in peripheral locations, the cost of which is reduced through waiving the land compensation fee and reducing other administrative fees, while placing limits on developers' profit margin. The eligibility of buyers is restricted to displaced inner urban residents and low-income households.

In recent years, encouraged by the booming commercial housing market and facilitated by increasing personal mobility, commercial housing estates have begun to take the lead in shaping the peri-urban interface. The newly emerging middle class groups seeking more space and better living environment at affordable prices, often choose to live in peri-urban areas, even though they do not work there [5]. Private-sector property developers race to build large integrated residential complexes with new commercial centres to service them.

Under the forces described above, three types of settlement are being shaped at the urban periphery of Chinese cities, they are *rural resettlement projects associated with farmland requisition; affordable housing compounds associated with inner-city regeneration; and real estate development of suburban commercial housing*. With these new master-planned settlements, the future of the peri-urban of Chinese cities is now gradually taking shape. The question remains, however, whether they have formed a foundation on which a sustainable future can be built?

3 SUSTAINABILITY OF PERI-URBAN SETTLEMENTS

In terms of addressing issues of sustainability in the peri-urban interface, different focuses are stressed between the developed world and the ‘Third World’ cities. In the post-industrial cities of the Anglo-American world, the 1960s and 1970s saw the rise of counter-urbanization, when the upper-middle class, being facilitated by widespread car ownership, sought to escape large congested and polluted cities to live in the surrounding countryside. Main public concerns over the trend of ‘suburbanization’ are on the environmental consequences of urban sprawl, increased vehicle ownership, and the loss of agricultural and forest land to greenfield development [6]. Key interventions in urban planning seek compact settlement forms and brownfield development [7]. Approaches taken include the improvement of public transport linkages and the creation and restoration of vibrant, walkable, compact and mixed-use communities [8,9].

The literature on sustainability of the peri-urban area of the Third-World cities is focused mainly on the issues of poverty and environmental management of the peri-urban interface. The association of peri-urban settlements with poverty, illegality and slums comes mainly from the literature in developing countries of South Asia, South America and Africa [10–13]. Enclaves of slum communities in the peri-urban surroundings are often associated with risk, vulnerability and susceptibility to diseases and contaminations [12]. The poverty issues are often interlinked with the environmental issues in that the poor are more exposed to the shocks and stresses of rapid urbanization such as inadequate water and sanitation arrangements [14] and health hazards [12]. Interventions to address poverty issues and environmental degradation point to improved institutional engagement and restructured management frameworks [15] and call for approaches that will tackle poverty alleviation and social justice alongside environmental integrity.

Table 1: Framework for evaluation of sustainable peri-urban settlements.

Sustainability dimensions	Sustainable peri-urban settlement theme	Requirements
Environmental	<i>Natural environment</i>	Ecologically responsible development; protection of natural resources; reduced energy consumption and diminished pollution
	<i>Accessibility</i>	Reduced reliability on automobile use; efficient public transport networks; accessible local public service facilities
Economic	<i>Agricultural land Employment and well-being</i>	Protection of agricultural land and rural economy Reduced poverty and improved well-being; vibrant local economy
Social	<i>Public participation</i>	Effective public participation in community planning and management

Being somewhat caught in between the First and the Third Worlds, China's peri-urban interface demonstrates characteristics of both. China's peri-urban areas witness the juxtaposition of wealthy suburban estates with low-income and rural communities, which means that the problems experienced in Los Angeles and in Jakarta are happening in one place. It suggests that the loss of environmental assets, agricultural land, congestion, energy crisis, environmental pollution, poverty and social degradation are interwoven issues that have all to be addressed at once [16]. To examine the sustainability of Chinese peri-urban settlement development, this study proposes a five-themed framework that seeks to incorporate all of the above issues and address the requirements of integrated environmental, economic and social goals (Table 1).

4 METHODOLOGY

This paper focuses on the sustainability evaluation of the outcome of peri-urban settlement development in Chinese cities, with an emphasis on residential estates. The methodology adopted in this study is an enquiry based on empirical evidence obtained from case studies. Three development cases located in the peri-urban areas of Tianjin, China, were chosen to be the study cases. Being the fifth largest city in China, Tianjin's urban development trend is representative of other large metropolitans in the country, the better understanding of which will inform future development decision-making. The criteria for the selection of the study cases were based on the fact that all of the cases lay claim to certain facets of sustainability in their planning and design proposals, and that they each represent one of the settlement types identified in Section 2. Several site visits to the chosen study cases were carried out between 2009 and 2010. Observations and informal discussions with the residents and the community management bodies of the study cases were done in the early site visits. These were followed by semi-structured and open-ended interviews with planning officials, representatives of the development companies, and planners and architects involved with the development and design of the estates under study. Planning documents, such as site master plans, planning proposals and design drawings were also obtained to gain a detailed understanding of the proposed designs.

The study examines the development outcome of three settlement cases in Tianjin against the framework given in Table 1. Their approaches and problems in relation to sustainability are identified and discussed. In conclusion, some generalisations are made on current development practice in Chinese cities, and some possible solutions to existing problems are discussed.

5 CASE STUDIES: PERI-URBAN SETTLEMENT DEVELOPMENT IN TIANJIN

Since the 1980s, urban master plans in major Chinese cities have implemented 'decentralized-concentration' growth management [1]. Tianjin's urban development in the post-reform era has followed this model. Urban spatial expansion in the last three decades has resulted in land within the designated greenbelt being filled by new urban developments. In the 'Tianjin Urban Master Plan 2005–2020', a polycentric urban structure was strengthened with the identification of the Binhai New Area, 40 km away from the main urban centre and home to the burgeoning Tianjin Economic-technology Development Area, as a secondary urban centre with a port. Fourteen peripheral residential settlements were planned between the two urban centres with greenfields in between them, estimated to accommodate an additional population of 1.41 million by 2020. In this section, the recent development of peri-urban residential settlements in Tianjin is discussed, using three exemplar cases, all of which being large-scale 'flagship' developments proposed and developed in the last 10 years (Fig. 1).



Figure 1: Location of study cases on the metropolitan map of Tianjin.

5.1 *In-situ* resettlement of rural community: Huaming New Town

In 2005, the township of Huaming, a suburban township administrating 15 villages on an area of 181 km², was appointed as a laboratory for the EZA programme. The programme was directly under the leadership of the Deputy Mayor of Tianjin and its implementation was administered by the local authority of the suburban district of Dongli. Huaming New Town (HNT), the planned conglomerated settlement encompasses a residential estate accommodating 42,000 rural residents relocated from the old township; a 7.3 km² industrial park featuring high-tech and innovative industries to the west of the residential estate; and an agricultural zone based on re-cultivation of the reclaimed *zhaijidi*.

By September 2007, the residential estate had been completed. From the outset, the new settlement resembled a typical metropolitan compound with 5- to 11-storey apartment building blocks and a central commercial street encompassing retail shops, banks, a food market, restaurants and a post office, many of which were relocated village businesses. The farm-edge trees and water bodies of the previous farmlands, on which the new town stands, have been preserved as much as possible (Fig. 2a). The rural communities and their administration structure were largely intact as whole villages were relocated into the new neighbourhoods [17]. All buildings in the estate were constructed to comply with the 2004 energy efficiency standards, which stipulates 65% energy-saving compared with the 1980s design standard, which is by far the strictest energy-efficiency design standard implemented in the nation. With funding from the local government, a solar hot water system has been installed for all housing units, with a bio-gas system installed for every neighbourhood to provide alternative cooking fuel. It was estimated that an annual reduction of 3,277 tonnes of CO₂ can be achieved from using renewable energy sources [17].

The re-cultivation of *zhaijidi* started in 2007, and following the levelling of 142 hectares of former *zhaijidi*, 427 greenhouses have been established, growing vegetables and fruits to sell to the city market all year round (Fig. 2b). The lease of the industrial park and the agricultural park, together with the rent collected from the commercial properties within the residential estate are estimated to generate 120 million yuan (1 yuan = 0.09 British Pound) of annual revenue for the town government and provide 8,000 jobs for its residents. Meanwhile, the local government uses the value-added gains from the land to buy social insurance for the landless farmers, equivalent to a pension of 400–500 yuan a month when they meet the statutory age. Public participation was given emphasis in the programme proposal, requiring public hearings at the village level, and overall villager consent before initiation of the programme [18]. Aimed at creating a successful model for the lives of farmers that is ‘ecological, harmonious and habitable’ [19], HNT was exhibited as the Urban Best Practices Area of World Expo 2010.



Figure 2: (a) Huaming New Town: modern residential building blocks amongst preserved farm-edge trees (photo taken by the author). (b) Re-cultivation of former *zhajidi* with greenhouse farming (Source: www.022net.com).

5.2 Affordable housing compound: the New Homes projects (NH)

Worldwide, rapid urbanization has been exerting huge pressure on housing provision, especially for the lower-income groups. Since the Chinese housing industry has become more market driven from the previous work-unit-based state welfare system, housing affordability of medium- to low-income households has been greatly affected by the commodification of the majority housing provision [20]. With rocketing property prices accompanied by inner-urban regeneration, the increasing demand for affordable housing for the poor has met with inadequate public funding. In response to the criticisms of the pro-profit housing policies and calls for government interventions in speeding up affordable housing provision, the Tianjin Municipal Government launched the ‘New Homes’ (NH) programme in March 2007. Ten residential communities are proposed within 5–10 km of the green belt, requiring an area of 4,824 hectares and housing a total of 819,600 residents by 2017.

In October 2009, the first NH project, Huaming New Homes, was completed and ready to welcome its first residents. In order to keep the housing prices down, the NH projects feature high-density gated communities with 11–20-storey apartment buildings and small housing units (Fig. 3a). Schools, kindergartens, food markets, community centres, clinics, banks, post offices and bus terminals are also planned to service each community. Similar to HNT, the NH projects also received funding to supply all homes with solar-powered hot water. Where roof areas are inadequate, balconies are used to install solar collectors (Fig. 3b). The construction of the residential buildings has been regulated by the 2004 energy-efficiency design standard.

5.3 Suburban commercial housing estate: the Dongli lake development

Dongli Lake Development (DLD) is a commercial housing estate developed by China Vanke Co. Ltd. (Vanke), one of the forerunners in China’s real estate sector. DLD was to be Vanke’s first flagship sustainable development project. On a site of 273 hectares, a total floor area of 1.37 million sqm of housing is being developed on the north bank of Dongli Lake, the largest ecological conservation area of Tianjin.

Starting in 2003, an 8–10 year development plan was devised to turn the area into a new town that incorporates residential, education, tourism and leisure facilities. New Urbanism concepts were proposed for the plan, featuring a mixture of housing types from detached European-style villas to contemporary-looking high-rise apartment blocks, and a range of commercial facilities that provides



Figure 3: (a) Huaming New Homes: completed but largely unoccupied (photo taken by the author).
(b) Solar collector fitted on balcony (photo taken by the author).

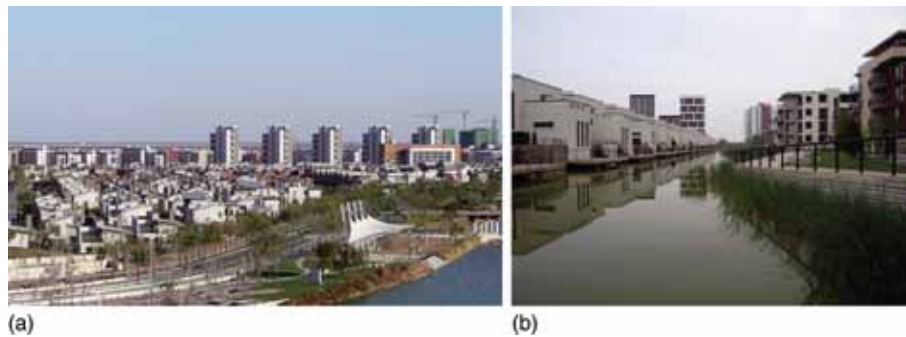


Figure 4: (a) Dongli lake development: mixed housing density and types (photo taken by the author).
(b) Engineered water marsh as aesthetic focal point of community (photo taken by the author).

the convenience of urban life (Fig. 4a). In 2005, 2,200 hectares of the Dongli Lake wetlands were listed as ‘Natural Wetlands Conservation Area (County-level)’ [21]. This had led Vanke to reassess their initial plans and emphasis was put on the preservation of the wetlands that were within the development site. International teams specializing in sustainable engineering and ecological design were invited to inform the revised site master plan, and provide technical and wetland design support. The result was a design approach that captures and treats storm water from the entire site, before it is discharged to Dongli Lake, in a series of wetlands (Fig. 4b). These constructed wetlands also serve as an aesthetic focal point of the community and a habitat for improved biodiversity. DLD adopted the LEED standard for building energy-efficient design, which was at the time ahead of all other similar developments in Tianjin.

6 EVALUATION OF SUSTAINABILITY IN PERI-URBAN SETTLEMENT DEVELOPMENT IN TIANJIN

In this section, the development outcome of the three chosen study cases (HNT, NH, DLD) are evaluated using the five-themed framework proposed (Table 1). Within each proposed theme, a comparison is made between the study cases on their specific approaches towards achieving goals required of that theme, and the effect of the developed outcome analysed.

6.1 Theme 1: natural environment

Compared to the informal settlements in cities of other developing countries, sanitation and pollution problems ceased to be the major concerns in the planned modernized peri-urban residential settlements. Yet the high magnitude of demographic growth in the peri-urban areas will inevitably induce accelerated depletion of natural resources and cause increased burden on the natural environment.

Due to the enforcement of the new regulations on building energy-efficiency design, both HNT and NH were constructed to higher energy-efficiency standard compared with developments prior to the introduction of the 2004 building energy-efficiency design standard. The energy-efficiency design was done mainly through improvement on window detail design to prevent thermal bridging, increased wall and roof insulation to reduce heat loss in winter and the design of ventilated roof to reduce heat gain in summer. DLD adopted the LEED standard for building energy-efficiency design ahead of the enforcement of the new national standard, which indicated its intention of being the forerunner in real estate market for sustainable design.

Renewable energy systems, specifically the solar-hot-water system, were widely implemented in the two government-led cases, i.e. HNT and NH, while receiving partial implementation in the private-sector development case, i.e. DLD (solar-hot-water systems were installed only on the single-family houses of Phase III development). In both HNT and NH, policy support and public funding were provided for the installation of solar-hot-water systems for each housing unit. In DLD, the lack of policy and financial support has made the use of solar-hot-water for every home unprofitable for the developer, which explains its partial application.

In DLD, it is witnessed that a policy transition towards increasingly recognizing the importance of the protection of natural environmental asset and biological diversity has made a huge impact on the development decision-making of peri-urban settlements, as demonstrated by the wetland preservation schemes in response to new planning regulations. However, there is still conflict between sustainability and profitability in the case of commercial housing development, as an interview with a representative of Vanke Property Management Ltd. revealed that the maintenance of the greenery and the wetlands requires huge amounts of investment on labour-intensive work, and that the company is 'losing money' on this in exchange for a pleasing appearance to attract potential home buyers. While it is doubtful that the engineered ecology of DLD can be truly sustainable in environmental and economic terms, there is also the question of whether public assets such as natural wetlands should be appropriated as private development sites. Past research has noted the reinforcement of unequal conditions of environmental quality on different social groups as a result of private appropriation of land – freezing access to and cancelling ecological functions of natural systems and subjecting lower-income groups to environmental hazards [22]. In the case of DLD specifically, a more sustainable approach would have been to retain open access to the wetlands for public use and engage the municipal government in its maintenance rather than relying solely on the private sector.

At HNT, the approach of preserving the existing green/blue structures of the previous farmlands that the new settlement sits on has been in keeping with sustainability principles. The proposed EZA programme was directly aimed at preventing the negative effects on the ecological system by urban development as well as achieving economic sustainability and social stability. At NH, by comparison, no measures of preserving the existing environment have been proposed.

6.2 Theme 2: accessibility

All the cases described in this study suffer, to varying extents, from inconvenient access to public services due to their peripheral locations. Poor service infrastructure provision and lack of accessibility to work have led to the market failure of the first NH project. By August 2010, 10 months later than the

intended date for residents to move in, only less than 20 families (about 1% of completed units) had settled in. An interview with the representative of Tianjin Anju Project Development Company (the development company appointed by Tianjin Urban and Rural Construction Committee to supervise the development of the NH projects) revealed that, the difficulty of providing ample public services and the lack of job opportunities at the remote locations of the NH projects had led to the resistance from the majority target inner-urban residents to relocate to the New Homes. As a result, further NH developments were put on a hold.

Lack of service provision and low occupancy rate have also been observed at DLD. Being largely targeted at Tianjin's local urban elites and people from other regions seeking a holiday home, DLD has become a hotspot for speculation and second home purchases, which accounts partly for its current low occupancy rate. Despite Vanke's struggles with the provision of the proposed facilities, it proved to be difficult when the occupancy rate is low: A well planned and beautifully finished primary school within the estate was forced to close down due to difficulties at recruiting enough students; local food markets and retail shops struggle to sustain their businesses; and transit companies are reluctant to extend their bus lines to the site for fear of low profit. Indeed this becomes a vicious circle whereby, the inadequate service provision further inhibits potential residents.

Comparatively, HNT has had more success at service accessibility, as previous village businesses were allowed to continue to operate in the new town and policy support was provided for service companies to extend their branches here. However, public transit services are still inadequate and high-quality commercial and social services are hard to sustain.

6.3 Theme 3: agricultural land

The EZA approach, being experimented at HNT, demonstrates an innovative attempt to resolve the conflict between urban development and the preservation of cultivation land. Although much work is still under progress, it is justifiable to assume that a balance can be achieved between agricultural land loss and increased agricultural land, in quantity terms at least. The question that remains unresolved is, however, whether the productivity and ecological quality of the replacement, former *zhaijidi* will meet the standard required to form a sustainable ecological system. High-quality re-cultivation requires that the new landscape offers a substitute and an offset for the lost land while providing a long-term living and economic basis for generations to come. The re-cultivation approach taken at HNT is indoor-based using mainly fruit and vegetable greenhouses as opposed to open-air re-cultivation based on soil remediation and replantation. It thus avoids many of the uncertainties and costs associated with soil treatment and maintenance. However, the impact on the ecosystem and biodiversity was neither mentioned in the initiatives nor assessed during and after the re-cultivation. This infers that the EZA approach was more from a land-use perspective than an ecological one and overlooked the issue of maintaining a balanced ecosystem. The fact that the majority of relocated villagers became landless after the implementation of EZA suggests that it might be just another way of getting around the policy restrictions on farmland acquisition for urban development, and may even instigate further loss of prime farmland under the disguise of innovative land use strategies. At NH and DLD, the agricultural lands within the development areas have been appropriated for urban development and ceased production long before constructions began. The original rural residents were relocated elsewhere with monetary compensations for their lost home and farmlands.

6.4 Theme 4: employment and well-being

A viable local economy is essential to the sustainability of communities, in that it provides a decent well-being for its members. As the studied cases present, the employment problem created by the

transition from an agricultural-based to the industry-based economy cannot be easily resolved as that of land use. In HNT, a collective factory specializing in modern methods of farming has been established to take over farming in the new town's agricultural parks. Landless farmers have been given monetary compensation, calculated according to the yield of their farms, plus other social benefits previously enjoyed only by urban residents. The town committee has been actively involved in preparing the farmers for non-farming jobs. However, as revealed by an unpublished survey report on farmers' satisfaction with the EZA programme, many respondents expressed dissatisfaction with their future work prospects as there seems to be a mismatch between the job opportunities available and the farmers' qualifications, with most of them still favouring agriculturally based jobs [23].

Difficulty at maintaining a viable local economy and job market has also been observed in other peri-urban communities. For the residents of NH, being relocated to the urban edge from their previous central-urban communities entails long daily commutes or changing of jobs to the periphery, neither of which appears feasible due to the low ownership of private vehicles and the relatively low job availability on the periphery. The low occupancy of DLD has also made it difficult to maintain a viable local economy, yet the fact that most of the current occupants being workers in the neighbouring industrial parks imply a strong correlation between the choice of living in peripheral settlements and the opportunity of finding jobs nearby.

6.5 Theme 5: public participation

The EZA programme experimented at HNT was intended as a flagship for public participation in rural urbanization. The public hearings and consultations that were carried out have been positively embraced among the rural communities, while minimizing conflicts between the local authority and the public, which were common in previous cases of farmland expropriation. However, it was observed that public participation was largely limited to the housing exchange process, with planning and design decision-making still dominated by authoritative decision and professional opinion. Moreover, although resettlement was proposed as being voluntarily based, the innate rationale of the EZA programme requires that all villagers be relocated before the village land can be re-cultivated so as to achieve the balance between lost and increased farmland. Therefore, to the village residents, 'not moving' was never really an option. NH and DLD showed no specific endeavour in involving local and affected communities in decision-making, with agreements of land expropriation signed between the village/town government and the developer. Financial compensation was then distributed to farmers on the condition that they leave their land to move to resettlement housing estates or homes elsewhere.

7 DISCUSSION AND CONCLUSION

A summary of the analysis of the study cases is presented in Table 2. From the analysis in the previous section, some generalizations can be made on the current practice of peri-urban settlement development in China.

It is noted that there has been a policy shift towards more 'pro-environment' and 'pro-poor' approaches in new Chinese peri-urban developments. Sustainable technologies such as solar-hot-water systems and energy-efficiency building regulations have been widely adopted with public funding support and regulatory interventions. The spontaneous act by private-sector developers to adopt the above-regulation energy-efficient design standards indicates that there is fast-emerging market demand for sustainable housing products. The protection of natural resources, especially agricultural land and wetlands, has been strengthened through strict state- and county-level regulations exerting significant impact on local development decisions. Meanwhile, innovative policies

Table 2: Summary of case studies in Tianjin.

Type of settlement	Name of study case	Approaches to sustainability	Key challenges	Possible solutions
1. <i>In-situ</i> resettlement of rural community	Huaming New Town (HNT)	<ol style="list-style-type: none"> 1. Balance urban development with farmland preservation by means of re-cultivation 2. Preserve existing green/blue structures 3. Preserve original rural administrative structure 4. Preserve village businesses 5. Improve quality of living for the farmers 6. Improve building energy efficiency and 7. Use of renewable energy 8. Public participation 	<ol style="list-style-type: none"> 1. Questionable long-term rural ecological sustainability with fruit/vegetable greenhouses to compensate for lost farmland 2. Limited opportunities for landless farmer re-employment 3. Inadequate public transit service 4. Low-quality public service facilities 5. Increased living cost and less self-sufficiency for rural households 6. Limited public involvement in planning 	<ol style="list-style-type: none"> 1. Ensure rural ecological stability through knowledge-based evaluation and regulation 2. Increase rural income and opportunities of agricultural-based jobs 3. Prioritize brownfield redevelopment over greenfield development 4. Improve public transit provision 5. Improve quality of public service facilities 6. Encourage and provide space for family and community-based businesses 7. Give voice to rural communities and facilitate in more self-initiated rural urbanization and cater to different individual needs

Continued

Table 2: *Continued*

Type of settlement	Name of study case	Approaches to sustainability	Key challenges	Possible solutions
2. Affordable housing compound	New Homes (NH)	<ol style="list-style-type: none"> 1. Provide housing for displaced inner-urban residents 2. Improve housing affordability for lower-income class 3. Improve quality of living for the poor 4. Improve building energy efficiency 5. Use of renewable energy 	<ol style="list-style-type: none"> 1. Lack of consideration for protection of natural environment 2. Failure to meet the needs of target groups 3. Imbalance between work and housing 4. Inadequate public transit services 5. Poor public service accessibility 6. Lack of public participation 	<ol style="list-style-type: none"> 1. Prioritize brownfield over greenfield development 2. Prioritize central over peripheral locations for affordable housing development 3. Give voice to target groups and cater for different needs 4. Increase public funds in affordable housing provision 5. Ensure adequate public transit and services facilities are provided upfront sale of properties 6. Improve quality of public services facilities 7. Encourage and provide space for community-based businesses 8. Introduce and facilitate public participation
3. Suburban commercial housing estate	Dongli Lake Development (DLD)	<ol style="list-style-type: none"> 1. Preserve natural wetlands 2. Building energy efficiency 3. Use of renewable energy 4. Mixed housing types 	<ol style="list-style-type: none"> 1. Questionable success with wetland preservation due to its fragile ecology, expensive maintenance and cancellation of public open access 2. Limited application of renewable energy system 3. Inadequate public transit and services provision 4. Imbalance between work and housing 5. Lack of public participation 	<ol style="list-style-type: none"> 1. Government involvement and public funds to help maintain natural wetlands 2. Maintain public access to natural environmental assets 3. Ensure adequate public transit and services facilities are provided upfront sale of properties 4. Encourage and provide space for community-based businesses 5. Introduce and facilitate public participation

and strategies are being experimented to address the issue of social equity caused by both the historical rural-urban dichotomy and the on-going polarization of society. The studies that have been conducted in the three chosen development cases reveal that, despite some level of success at achieving their goals, there still remain unresolved problems that pose challenges to environmental integrity, economic vitality and social well-being of these communities.

The observation that renewable energy systems have been more successfully implemented in the government-led developments than the private-sector development implies that policy and financial support are essential for housing developments to take renewable energy on board and balance the increased primary input and maintenance costs, which are the main obstacles hindering wide application of renewable energy systems. The conflict between urban spatial expansion and preservation of natural environmental assets, such as forestland, wetlands and farmland, is still intense albeit receiving increased public attention and policy interventions. While there is no doubt that the EZA approach is a step forward from the uncoordinated requisition of farmland for urban development, its success to offset the adverse effects of urban growth remains to be justified upon further evidence of long-term food production stability and ecological environment sustainability. Strengthened state-level legislations on environmental preservation and their observance through planning permissions are also required in order to see through the ensured implementation of sustainable strategies. Moreover, infill and brownfield development should be encouraged through enforced regulations, policy and financial incentives and planning control mechanisms, so as to relieve the burden of peri-urban development on greenfield sites and agricultural lands.

As is observed in the studied cases, poor accessibility to public transit, service facilities and work plagues all types of peri-urban settlement. Compared with the physical product, urban consumer services have been accorded less priority among Chinese urban decision-makers. Furthermore, planned peri-urban settlement developments favour self-enclosed compounds in greenfield sites, which are difficult to integrate with existing communities and infrastructure. As these cases present, the provision of good public transit links, quality educational facilities, consumer and social services is critical for the sustainability and prosperity of peri-urban communities. As private car ownership is still comparatively low and public transportation is inadequate, the prospect of availability of local employment and the viability of local economy are also key components for a sustainable peri-urban community. Further, settlement plans that entail transformations of rural communities need to be made with caution as the mismatch of the supply of former rural labours with the demand for skilled workers of the modernized industries remains a huge problem that needs more than community design to resolve. These would include investment in human capacity building in the rural sector, increased rural incomes through higher yields and guaranteed prices, improved rural infrastructure, and above all, a paradigm shift from primarily focusing on eye-pleasing physical environment creation to spreading improvement of life standards and economic well-being for rural communities.

The NH projects represent the authority's strong will and an urgent desire to resolve the affordability issue for housing the urban lower-income class. As the evidence from this study has shown, there has been misjudgment by the planning authority on the location of the NH projects, which were exclusively on the urban outskirts. This suggests that the strategy of using cheap, peri-urban land for affordable housing development is questionable. It also implies that there has been lack of communication between the planning authority and the targeted residents on the development plans of these communities during their planning process. The absence of public participation in community design is found to be prevalent with peri-urban settlement development in Tianjin, which all took a centrally led town-making approach that focused more on physical construction than the building of self-sustaining communities. With the 'top-down' approach dominating urban planning in China, the empowerment of the general public remains limited. This centralized approach prevents

the exchange of information and ideas between the city designers and the true masters of the city at the grassroots, and it overlooks the differences in individuals' needs. It might be time for the urban decision-makers to rethink the campaign-like wholesale approach of peri-urban town-making and seek to assist in more spontaneous and 'bottom-up' actions leading to peri-urbanization that are based on the genuine need of self-improvement.

The studied settlement cases in Tianjin demonstrate new interventions to old problems that exist within rapidly urbanizing cities, i.e. the loss of natural environmental assets, increasing burden on energy and resource use, impoverishment of disadvantaged groups and deteriorating local economic resilience. Their approaches demonstrate traits of sustainable development principles that cover environmental, social, and economic dimensions. However, the innovative schemes adopted by the cases studied here, despite laying claim to sustainability, are each found to be promoting only certain facets of the sustainability agenda, and there are significant omissions prevalent to all types of peri-urban settlement development, such as the issues of power generation and clean fuels, the collection and treatment of domestic and industrial wastes, and urban spaces assigned to green and leisure zones. It is found that a holistic agenda to achieve sustainability is currently lacking within peri-urban settlement development, an agenda that takes into account current issues and integrates environmental, social and economic aspects of sustainability. A clear framework, therefore, needs to be structured indicating priorities and goals, drawing out evaluation principles and procedures. Restructuring of the current decision-making system would need to be implemented in order to set up a successful partnership amongst sectors of the society that includes authority, industry and most importantly, the public.

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