

Physical and mental health impacts of household gardens  
in an urban slum in Lima, Peru

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**Abstract**

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**Background:** Rural poverty and lack of access to education has led to urban migration and fed the constant growth of urban slums on the outskirts of Lima, Peru. These informal settlements suffer from lack of public access to water and sanitation, informal land rights, food and water insecurity, all of which contribute to poorer health outcomes. We explored the feasibility of implementing household gardens using participatory design methods and examined the impact of increased green space on wellbeing.

**Methods:** Between September 2013 and September 2014, we conducted a repeated measures longitudinal study with 29 community members in an

informal settlement of 82 households in Lima, Peru. We assessed changes in physical and mental health after participatory design and construction of household gardens. Anthropometric data and a composite of five validated mental health surveys were collected at baseline, 6-months, and 12-months after garden construction.

**Results:** Twelve months after garden construction, we found significant increases from baseline in all domains of quality of life—physical ( $p < 0.01$ ), psychological ( $p = 0.05$ ), social ( $p = 0.02$ ), and environmental ( $p = 0.02$ )—in overall social capital ( $p < 0.01$ ), and perceived stress ( $p < 0.01$ ). Life threatening experiences decreased compared to baseline significantly ( $p = 0.02$ ). There were no significant changes in parent or partner empathy ( $p = 0.21$ ), BMI ( $p = 0.95$ ), waist circumference ( $p = 0.18$ ), or blood pressure ( $p = 0.66$ ) at 6 or 12 months. Fasting blood glucose increased at 6-months ( $p = 0.04$ ), but this change was not maintained at 12-months ( $p = 0.59$ ).

**Conclusions:** Improved access to green space in the form of a household garden can significantly improve mental health in a slum setting.

**Keywords:** social capital, quality of life, green space, mental health, Peru, urban slum

## **BACKGROUND**

### Urban development context

Of Lima's 8.5 million inhabitants, an estimated 85% live in informal settlements (1). Informal settlements "(i) were built in violation of express laws, (ii) did not comply with requirements for access to land, (iii) were originally formal but became informal, or (iv) were built by the government without complying with legal requirements" (2). Many informal settlement residents live in poverty and qualify as a slum household, defined by the UN as "a group of individuals living under the same roof in an urban area who lack one or more of the following: (i) durable housing of a permanent nature that protects against extreme climate conditions, (ii) sufficient living space which means not more than three people sharing the same room, (iii) easy access to safe water in sufficient amounts at an affordable price, (iv) access to adequate sanitation in the form of a private or public toilet shared by a reasonable number of people, (v) security of tenure that prevents forced evictions" (3). People living in slums face complex, intertwined issues including food and water insecurity, geographic and political marginalization, and poorer health outcomes (4).

In the arid Lima area, green space is limited and concentrated in affluent areas. Within slum neighborhoods, access to green spaces is extremely limited, which places the residents and their families at greater risk for mental illness, social isolation, increased stress, and reduced quality of life (5). Urban gardens have gained popularity for their potential to improve physical, mental, and

environmental health in low-income settings (6). Although many studies have been conducted in poor neighborhoods in high-income countries, little research has been done on green space interventions in low- and middle-income countries like Peru (ibid).

### Physical health impacts

Access to green space can increase food security, improve air quality, and have protective effects against the onset of cardiovascular diseases and diabetes (7). Green space in the form of urban gardens has been documented to improve access to nutritious food and, if the gardens are large enough, to shield slum dwellers from volatile food prices (8). Furthermore, trees, bushes, and other plants filter out pollutants including ozone, particulate matter, and nitrogen dioxide, therefore improving air quality (9). They also provide shade and protect people from heat and sun-related illnesses (10, 11). Previous investigators have found that, in Peru, low socioeconomic status is strongly associated with higher burden of non-communicable diseases (NCDs) such as Type 2 diabetes and cardiovascular diseases (12, 13). As the burden of NCDs increases in LMIC, we need community-based interventions to better prevent the onset of NCDs in these settings (14).

### Mental health

Previous research in the Netherlands has documented that green space improves self-reported health through the mechanism of significantly reducing stress and promoting social cohesion in neighborhoods (15). Although urban

centers provide a dense network of resources, there are also unique urban stressors like noise pollution and fear of crime. Researchers suggest that people's affinity for green space within cities stems from its restorative function which alleviates and reduces stress (16). Additionally, another study in Australia highlights the association between individual mental health outcomes and the perceived quality—not just quantity—of green space (15, 17). Especially in the absence of government support, slum residents rely on social cohesion to generate social support and to catalyze collective action within their neighborhood, most of whom have no familial connections and may come from different cultural backgrounds (18).

#### Environmental context

Coastal Peru has less than one inch of rain per year, and is particularly vulnerable to this explosive urbanization. Water for Lima's 9 million people comes from rivers that are fed by Andean glaciers, which are melting at an unprecedented rate (19). The combination of increasing water insecurity, changing ocean temperatures, and rapid urbanization make healthy urban ecosystems and increased green space increasingly important. Furthermore, green space is critical to preventing erosion, landslides, and soil degradation.

#### Local context

Slums in Peru often begin as "invasions," with a group of families constructing makeshift houses on vacant land. In order to apply for the land title, neighborhoods must work together to bring the area into compliance with local

regulations such as land stabilization and mapping of formal land parcels. With the recognition from the city comes access to public water and sanitation, road construction, educational, and health services.

Alto Zapallal is in the northern cone of Lima and home to approximately 30,000 residents. One of the newest settlements is Eliseo Collazos, founded within the last 6 or 7 years. Eliseo Collazos was built around the slopes of a former clay mine. Eliseo Collazos is a growing informal urban settlement of about 90 families. Residents have purchased and registered their lots, but are in the process of gaining property titles. Most families have built prefabricated houses on unstable hills. The majority of homes have electricity, but the neighborhood is not connected to municipal water or sanitation services. Historically, water was delivered through a central hose or brought in by truck and sold by a private water company. Sanitation is limited to outhouses and makeshift showers.

### Collaboration

In order to gain trust in Eliseo Collazos, this project engaged the community as well as academic and local partners through the Informal Urban Communities Initiative (IUCI). IUCI is a partnership between the University of Washington, the Fundación San Marcos in Peru, and various neighborhoods in Alto Zapallal. The purpose of IUCI is to improve smaller scale projects to bring sustainable change to Alto Zapallal. IUCI has used participatory design methods for landscape, engineering, and health projects in the northern cone of Lima since 2007 (20).

## Objectives

The purpose of this 1-year pilot study was to investigate the effects of individual household gardens on the health of slum dwellers in Lima, Peru. We had three aims. In an urban slum community:

1. What are the physical health changes at six and twelve months after the introduction of individual gardens in terms of BMI, fasting blood glucose, blood pressure, and waist circumference?
2. What are the mental health changes at six and twelve months after the introduction of household gardens as measured by perceived stress, empathy towards their partners and their children, threatening life experiences, quality of life, and social capital?
3. Was any baseline demographic variable associated with participants ultimately constructing a garden?

## **METHODS**

### Study Design

We conducted a longitudinal study with measures taken at baseline, 6 months, and 12 months post implementation. Information was collected in questionnaire form by making appointments with each participant and verbally asking participants to respond to questionnaire items, or subjects could choose to complete the questionnaire on their own.

## Measurements

The demographic information that we collected included age, gender, marital status, education, monthly household income, number of adults in household, number of minors in household, years lived in the community, language(s) spoken, province of origin, previous residence, reason for moving, whether participant was currently ill, alcohol and smoking status, physical activity, and condition of mouth and teeth.

The physiological measures included basic biometric measures of height, weight, waist circumference, resting blood pressure, and fasting blood glucose using standardized procedures. The same scale, blood pressure cuff, and blood glucose meter were used for all participants at all time points.

## Mental Health Instruments

Mental health dimensions were assessed using the Spanish translation of several tools: the World Health Organization Quality of Life-Brief Version (WHOQOL-BREF), the Perceived Stress Scale (PSS), the Life Threatening Experiences 12 and 20 items (LTE-Q), the Social Capital Scale (SCS), and the Parent/Partner Empathy Scale (PPES). The combined questionnaire was validated in the community and adapted for local use.

The WHOQOL-BREF has four quality of life subscales: quality of life in the physical domain, the psychological domain, the social domain, and the environmental domain. This is the 26-item version, scored on a 5-point scale, with higher scores indicating higher quality of life (21, 22).

The PSS measures the degree to which the interviewee considers her/his situation stressful. The instrument has 14 items, and uses a 5-point response scale, with higher scores indicating higher levels of perceived stress. (23).

The LTE-Q asks whether 20 yes/no life events have occurred in the past three months. Higher scores indicate more recent life-threatening experiences (24, 25).

The SCS quantifies social capital through eight subscales: participation in the local community, social agency, feelings of trust and safety, neighborhood connections, friends and family connections, tolerance of diversity, value of life, and workplace connections. Example questions include, "How comfortable do you feel walking alone at night in your neighborhood?" and "In the last week, have you visited a neighbor?". We excluded workplace connections items in anticipation of the high rate of informal work in the slum community, leaving us a 36-item scale, which uses a 1-4 point response scale. Higher scores indicate higher levels of social capital (26).

The PPES uses a parent subscale and a partner subscale. There are 40 items with a 5-point response scale. Subjects respond how well each item describes them. For example, "My partner says I don't understand what they feel," or "When my child is bothered, it is hard to tell if s/he is sad or just nervous." Higher scores indicate higher levels of empathy (27).

### Recruitment

The study was announced through community meetings and posted flyers in June 2013. All community members were invited to a presentation that introduced the details of the study design. In order to participate in the project, participants had to commit 4 consecutive Sundays to attend workshops. In a community where most residents work six days a week, this constituted a huge commitment on the participants' part. The individual garden design and participatory workshops that led up to the garden planning and construction are described in detail elsewhere (28). Briefly, participants attended four Sunday workshops of four to five hours during July 2013 to envision what they want their community to look like in the future, to design a model of their personal garden with scaled models, and to learn about construction and cultivation methods. Following the presentation, researchers were available to answer community members' questions. Informed consent was obtained from residents that were interested in participating. Inclusion criteria were attending all workshops, age 18 years or older, ability to give informed consent, and residence in Eliseo Collazos. One participant attended workshops and constructed a garden, but was unable to complete the Spanish questionnaire because she only spoke an indigenous language. A total of 44 eligible residents signed informed consent.

### Ethics

Previous experiences including community meetings in 2011 and projects at the local school facilitated trust and support for the project. This community-

driven project identified lack of green space as one of their top priorities through a participatory impact assessment conducted in 2011. In 2013, the Institutional Review Boards of the University of Washington, the University of San Marcos, and the community members approved the study.

### Statistical Analysis

The main statistical test used was a paired t-test, showing the change in mean scores from baseline to 6-months and baseline to 12-months post garden construction. We also compared the baseline demographics of participants who completed workshops and built a garden with the demographics of participants who did not build a garden.

## **RESULTS**

We collected baseline data on 44 adult community members. Of these participants, 29 completed all the workshops and constructed a garden on the perimeter of their house (Annex 1). Those who did not build a garden were younger, more likely to be male, single, and had a lower monthly income when compared to the residents who did construct a garden (Table 1). In order to determine whether there were underlying differences between people who built a garden and people who did not ultimately construct a garden, we present the stratified data.

**Table 1** Baseline Demographics of Study Participants

Characteristic	Did not construct a garden N=15		Constructed a garden N=29	
	n	%	n	%
Age (years)*	<i>31.9</i>	<i>19, 58</i>	<i>34.5</i>	<i>21, 58</i>
Female	13	86.7	27	93.1
Language				
Spanish and Quechua	3	20.0	6	20.7
Spanish only	12	80.0	23	79.3
Marital Status				
Single	5	33.3	1	3.5
Live together	6	40.0	22	75.9
Married	2	13.3	1	3.5
Separated	2	13.3	5	17.2
Education* (years) †	<i>10.6</i>	<i>1, 22</i>	<i>9.3</i>	<i>0, 20</i>
Monthly income (soles) †				
0-374	7	46.7	6	20.7
375-749	6	40.0	16	55.2
750-1500	1	6.7	7	24.1

\*mean, range

†1 missing value

Changes in biometry from baseline to 6-months and baseline to 12-months among those who constructed a garden are shown in Table 2. There was no significant change in BMI, waist circumference, or blood pressure at either follow-up. The mean BMI fell at the high end of the normal range at all time points. Waist circumference varied among subjects, but the mean at baseline and 12-months was slightly higher than the recommended 88.9 cm. At all three measurements mean fasting blood glucose fell within the normal range (79.2-110 mg/dL). At 6-months, we detected a significant increase in mean fasting blood glucose, but at 12-months, the change in mean fasting blood glucose was non-significant. Mean blood pressure fell below the recommended 120/80.

**Table 2** Physical Health Metrics at Enrollment, Six and Twelve Month

Outcome	Baseline N=29		6-months N=28			12-months N=26		
	mean	sd	mean	sd	p	mean	sd	p
BMI	24.3	5.1	24.1	5.2	0.12	24.5	5.5	0.95
WC* (cm)	89.4	13.4	87.2	8.5	0.40	92.8	13.2	0.18
FBS <sup>†</sup> (mg/dL)	89.9	8.9	94.0	<b>7.2</b>	<b>0.04</b>	91.1	8.5	0.59
Systolic	115.2	11.4	115.5	9.0	0.75	114.6	15.9	0.66
Diastolic	72.3	10.1	73.0	10.0	0.77	73.8	9.4	0.69

\*Waist Circumference

<sup>†</sup>Fasting blood glucose

Results from the paired t-test for mental health variables are shown in Table 3. There was an increase in all domains of quality of life at 6-months that was not statistically significant. However, this increasing trend in quality of life improvement was significant in all domains at 12-months. Reports of life threatening experiences decreased significantly on both the 12-item and 20-item scale from baseline to 12-month. Perceived stress scores increased significantly at 6- and 12-months ( $p < 0.01$ ).

For the Parent Partner Empathy Scale, participants who self-identified as parents or partners changed over time. The PPES analysis only includes subjects on whom we have complete follow-up information. Four subjects were excluded due to incomplete follow-up. 3 surveys were incomplete, but were included in the analysis with missing items omitted.

Mean social capital scale scores increased slightly at 6-months and significantly at 12-months ( $p < 0.01$ ). We also saw significant increases in three

subscales at 12-months: the feelings of trust and safety ( $p=0.01$ ), the value of life ( $p=0.01$ ), and the family and friends connections ( $p=0.04$ ).

**Table 3** Mental Health Metrics at Enrollment, Six and Twelve Month

Outcome	Baseline N=29		6-months N=28		p	12-months N=26		p
	mean	sd	mean	sd		mean	sd	
WHOQOL-BREF*								
Physical	13.3	2.0	13.4	2.8	0.67	<b>15.5</b>	<b>2.4</b>	<b>&lt;0.01</b>
Psychological	14.3	2.3	14.7	2.4	0.24	<b>15.5</b>	<b>2.4</b>	<b>&lt;0.05</b>
Social	13.3	3.0	13.7	3.1	0.51	<b>15.1</b>	<b>3.0</b>	<b>0.02</b>
Environmental	11.8	1.5	12.0	1.7	0.56	<b>13.0</b>	<b>1.7</b>	<b>0.02</b>
LTE-12 <sup>†</sup>	2.0	1.7	2.1	2.2	0.85	<b>1.5</b>	<b>1.5</b>	<b>0.02</b>
LTE-20 <sup>‡</sup>	2.4	1.9	2.4	2.7	0.93	<b>1.8</b>	<b>1.8</b>	<b>&lt;0.05</b>
Perceived Stress Scale	23.8	<b>6.5</b>	<b>34.0</b>	<b>4.9</b>	<b>&lt;0.01</b>	<b>33.1</b>	<b>4.1</b>	<b>&lt;0.01</b>
PPES <sup>§</sup> (n=19)	141.5		137.2		0.15	145.6		0.21
Parent (n=24)	65.3		<b>61.4</b>		<b>&lt;0.01</b>	63.0		0.19
Partner (n=19)	65.2		65.9		0.74	68.0		0.08
Social Capital Scale	72.5	10.0	75.3	9.2	0.13	<b>83.6</b>	<b>10.1</b>	<b>&lt;0.01</b>
Trust/Safety	18.9	3.0	19.4	1.9	0.48	<b>20.3</b>	<b>2.8</b>	<b>0.01</b>
Participation	12.4	4.3	11.3	3.7	0.17	12.5	4.1	0.88
Diversity	6.0	1.4	6.0	1.2	1.00	6.4	1.3	0.31
Neighborhood	4.5	2.0	4.9	1.9	0.38	5.2	2.1	0.16
Value of Life	11.8	1.8	11.6	2.2	0.62	<b>13.2</b>	<b>1.9</b>	<b>0.01</b>
Family/Friends	6.1	1.8	6.7	1.6	0.13	<b>7.1</b>	<b>1.8</b>	<b>0.04</b>
Social Agency	2.0	0.9	1.9	0.9	0.81	1.9	0.9	0.79

\*WHOQOL-BREF: World Health Organization Quality of Life Brief Version

<sup>†</sup>LTE-12: Life Threatening Experiences, 12-item

<sup>‡</sup>LTE-20: Life Threatening Experiences, 20-item

<sup>§</sup>PPES: Parent/Partner Empathy Scale

## DISCUSSION

We found that, at 12-months, gardens were associated with significantly higher mental health scores as measured by quality of life, threatening experiences, and social capital. The improvement in mental health is consistent with other studies and demonstrates the benefit in this environment (6, 15).

The significant decrease in life threatening experiences, which is reported at an individual level, could indicate that the gardens promote more socializing and public presence in the neighborhood. Increased green space has been associated with increased socializing in other studies (16, 29).

The quality of life and social capital scales were the most sensitive to change, indicating that for future projects, use of these two scales could decrease the time burden of the questionnaire on participants. Understanding how to harness social networks to improve wellbeing and accelerate development will be critical as more people move into urban centers. This participatory design of household green space intervention methodology is feasible to conduct and was regarded very highly among the participants. It allowed them to make their own choices regarding garden placement, design, and content. These results also point to the synergy between the co-benefits of improving environmental health and human health.

Perceived stress increased significantly, more at 6-months than at 12-months. Based on focus group data (reported elsewhere), this result may reflect community members' perception of increased gang presence and militancy. The peak in perceived stress at 6-months also may reflect the difficulties of the hot, dry season and the impending start of school and related expenses.

Looking at physical health, we found that BMI in this community was lower than in a previous study in the Alto Zapallal area. A total of 30% of our participants were overweight or obese at baseline as compared to 53% in the

previous Alto Zapallal study. In the same study, 15% of participants had high blood pressure whereas only 2% of Eliseo Collazos subjects had high blood pressure (12). However, as a newer settlement, there may be important differences in variables like age and general health in Eliseo Collazos compared to the larger Alto Zapallal area.

Fasting blood glucose levels suggest that overall physical health is great in Eliseo Collazos. There was a significant increase in fasting blood glucose at 6-months, but not at 12-months, which may be associated with varying access to nutritious food by season. Residents report regular exercise from climbing the sandy hills in the neighborhood that cars and buses cannot navigate. In order to better assess the impact of gardens on physical health, future projects should also collect data on baseline nutrition and describe food intake at various time points. Furthermore, families did not exclusively use their gardens for food, differing from much of the literature on urban gardens. The expected changes would therefore be mediated through mental health, and we were likely underpowered to observe a significant mediated change in basic biometry at 12 months. In this participatory design where subjects chose their own plants, it would be impossible to conduct an *a priori* sample size calculation.

Underlying differences between participants who implemented the garden and those who did not suggest that this methodology may not benefit all community members, particularly single adults with lower monthly income. This

is reasonable, given that we would expect single adults to have less flexibility in their schedule.

We noted that after the implementation of workshops and construction of study gardens, other community members constructed new gardens in front of their homes. Future studies should document characteristics of all neighborhood households in order to better document community-level changes.

A particularly important variable for garden interventions in arid regions is access to water. Studies conducted in desert areas should include metrics on how much and what types of water are used for gardening to ensure sustainability of the green spaces.

### Limitations

Although our sample size was limited, 30% of all households in the neighborhood constructed a garden, which is a substantial portion of a single community. We were not able to follow up on participants who did not construct a garden to evaluate their reasons. Most likely, those heads of households were not able to dedicate the significant amount of necessary time to the initial workshops. However, we were still able to detect significant associations, suggesting that the garden project made a sizeable impact on the wellbeing of residents.

With a high rate of internal migration in Peru, many participants spoke both Spanish and Quechua. However, the proportion of bilingual residents was the same in the group that constructed a garden and the group that did not, so

we do not believe that language limited the population that benefited from the project.

The scales used were not all developed for use in our study setting. Some were validated translations, but some were geared towards populations of a higher socioeconomic and education level. For example, one question asks how many phone conversations with friends the participant has had in the past week. In our population, not all residents own cell phones, so we coded this answer as zero, when in reality, the question was not applicable. This could be remedied by creating a data analysis plan that includes an N/A option and details appropriate statistical tests.

We believe that the participatory design was a critical aspect of the study. In marginalized populations, this methodology empowers community members. Although this set a bottleneck for participation by requiring that families attend workshops, this also allowed families to customize the design and content of their garden which may increase the long-term sustainability.

## **CONCLUSION**

Our results highlight the interplay between individual, family, neighborhood, and societal levels of influence on wellbeing. Participatory green space interventions are feasible, and can have significant health benefits in urban slums. Future research could examine green space in a cohort study to better

examine changes in wellbeing that occur over time or throughout a community, regardless of whether the resident has a garden. Further investigation into dietary patterns before, during, and after a garden intervention would provide a more nuanced understanding of the health impact.

## WORKS CITED

1. Calderon J. The formalisation of property in Peru 2001–2002: the case of Lima. *Habitat International*. 2004;28(2):289-300.
2. de Soto H. *The Mystery of Capital: Why Capitalism Triumphs in the West and Fails Everywhere Else* 2000.
3. UN-HABITAT. *State of the World's Cities*. 2007.
4. Turley R, Saith R, Bhan N, Rehfuess E, Carter B. Slum upgrading strategies involving physical environment and infrastructure interventions and their effects on health and socio-economic outcomes. *Cochrane Database Syst Rev*. 2013;1:Cd010067.
5. Patel V, Kleinman A. Poverty and common mental disorders in developing countries. *Bulletin of the World Health Organization*. 2003;81(8):609-15.
6. Guitart D, Pickering C, Byrne J. Past results and future directions in urban community gardens research. *Urban Forestry & Urban Greening*. 2012;11(4):364-73.
7. Pereira G, Christian H, Foster S, Boruff BJ, Bull F, Knuiman M, et al. The association between neighborhood greenness and weight status: an observational study in Perth Western Australia. *Environ Health*. 2013;12:49.
8. Zezza A, Tasciotti L. Urban agriculture, poverty, and food security: empirical evidence from a sample of developing countries. *Food Policy*. 2010;35(4):265-73.
9. Nowak DJ, Crane DE, Stevens JC. Air pollution removal by urban trees and shrubs in the United States. *Urban forestry & urban greening*. 2006;4(3):115-23.
10. Escobedo FJ, Kroeger T, Wagner JE. *Urban forests and pollution mitigation: analyzing ecosystem services and disservices*. *Environ Pollut*. 159. England: 2011 Elsevier Ltd; 2011. p. 2078-87.
11. Cummins SK, Jackson RJ. The built environment and children's health. *Pediatric Clinics of North America*. 2001;48(5):1241-52.
12. Heitzinger K, Montano SM, Hawes SE, Alarcon JO, Zunt JR. A community-based cluster randomized survey of noncommunicable disease and risk factors in a peri-urban shantytown in Lima, Peru. *BMC Int Health Hum Rights*. 2014;14:19.
13. Goldstein J, Jacoby E, del Aguila R, Lopez A. Poverty is a predictor of non-communicable disease among adults in Peruvian cities. *Prev Med*. 2005;41(3-4):800-6.
14. Stenberg K, Chisholm D. Resource needs for addressing noncommunicable disease in low-and middle-income countries: current and future developments. *Global Heart*. 2012;7(1):53-60.
15. de Vries S, van Dillen SM, Groenewegen PP, Spreeuwenberg P. Streetscape greenery and health: stress, social cohesion and physical activity as mediators. *Soc Sci Med*. 2013;94:26-33.
16. Van den Berg AE, Hartig T, Staats H. Preference for nature in urbanized societies: stress, restoration, and the pursuit of sustainability. *Journal of social issues*. 2007;63(1):79-96.
17. Carter M, Horwitz P. Beyond proximity: the importance of green space useability to self-reported health. *Ecohealth*. 2014;11(3):322-32.

18. Daniere A, Takahashi LM, NaRanong A. Social capital, networks, and community environments in Bangkok, Thailand. *Growth and Change*. 2002;33(4):453-84.
19. Rabatel A, Francou B, Soruco A, Gomez J, Cáceres B, Ceballos J, et al. Current state of glaciers in the tropical Andes: a multi-century perspective on glacier evolution and climate change. *The Cryosphere*. 2013;7(1):81-102.
20. Initiative IUC. Available from: <http://sqwater.be.washington.edu/wp/>.
21. Skevington SM, Lotfy M, O'Connell KA. The World Health Organization's WHOQOL-BREF quality of life assessment: psychometric properties and results of the international field trial. A report from the WHOQOL group. *Quality of life Research*. 2004;13(2):299-310.
22. Group W. Development of the World Health Organization WHOQOL-BREF quality of life assessment. *Psychological medicine*. 1998;28(03):551-8.
23. Remor E. Psychometric properties of a European Spanish version of the Perceived Stress Scale (PSS). *The Spanish journal of psychology*. 2006;9(01):86-93.
24. Brugha T, Cragg D. The list of threatening experiences: the reliability and validity of a brief life events questionnaire. *Acta Psychiatrica Scandinavica*. 1990;82(1):77-81.
25. Motrico E, Moreno-Küstner B, de Dios Luna J, Torres-González F, King M, Nazareth I, et al. Psychometric properties of the List of Threatening Experiences—LTE and its association with psychosocial factors and mental disorders according to different scoring methods. *Journal of affective disorders*. 2013;150(3):931-40.
26. Onyx J, Bullen P. Measuring social capital in five communities. *The journal of applied behavioral science*. 2000;36(1):23-42.
27. Perez-Albeniz A, de Paul J. Gender differences in empathy in parents at high-and low-risk of child physical abuse. *Child Abuse & Neglect*. 2004;28(3):289-300.
28. Hou J, Spencer B, Way T, Yocom K. *Now Urbanism: The Future City is Here*: Routledge; 2014.
29. Nurse J, Basher D, Bone A, Bird W. An ecological approach to promoting population mental health and well-being—a response to the challenge of climate change. *Perspectives in public health*. 2010;130(1):27-33.

Annex 1: Garden progress



Counterclockwise from top left: Baseline, constructed garden, 6-months



Counterclockwise from top left: Baseline, constructed garden, 6-months