Chapter 2
Communities Hosting US Commercial Nuclear Power Plants

2.1 Setting Boundaries in Host Communities

Communities located around a nuclear power plant shoulder inevitable risks associated with the nuclear power plants. These inevitable risks include nuclear contamination, radiation, and nuclear core-meltdown accidents. In case of the worst accident scenario, an event with a core-meltdown accident at a nuclear power plant, communities near the site could face the risk of exposure to highly toxic radioactive plume. The areas that are prone to such radiation risks depend on how far the plume could travel and the weather conditions in that particular day. The NRC has designated two types of emergency planning zones (EPZs): a 10-mile radius zone and a 50-mile radius from a nuclear power plant (US NRC 2016). The first 10-mile radius zone around the nuclear power plant is called the plume exposure pathway, whereas the latter one is named the ingestion exposure pathway. The difference between the two zones is the emergency management plan for each. The plume exposure zone (PEZ) requires a mandatory and detailed emergency management plan, whereas the ingestion exposure zone (IEZ) is not required a mandatory emergency management plan. However, the two zones share a common goal of avoiding or reducing potential radiation. The PEZ with predetermined protective action plans is designed to avoid or reduce radiation by sheltering, evacuation, and the use of potassium iodide, whereas the IEZ is designed to avoid or reduce potential ingestion.

To define the host community of a nuclear power plant, I consider the 50-mile distance based on the NRC's predetermined two emergency zones: a 10-mile radius and 50-mile radius. Therefore, in this chapter, communities hosting nuclear power plants are defined as those communities living around a 50-mile radius from a nuclear power plant, as designated in both exposure pathway and ingestion pathway by the NRC (US NRC 2016). However, a group of more than 37 environmental and civic organizations argued that the 50-mile radius is not a sufficient distance because the radioactive plume could travel longer than the specified distance, as evident in the events of Chernobyl and Fukushima (NIRS 2013; Kyne 2014). In acknowledging

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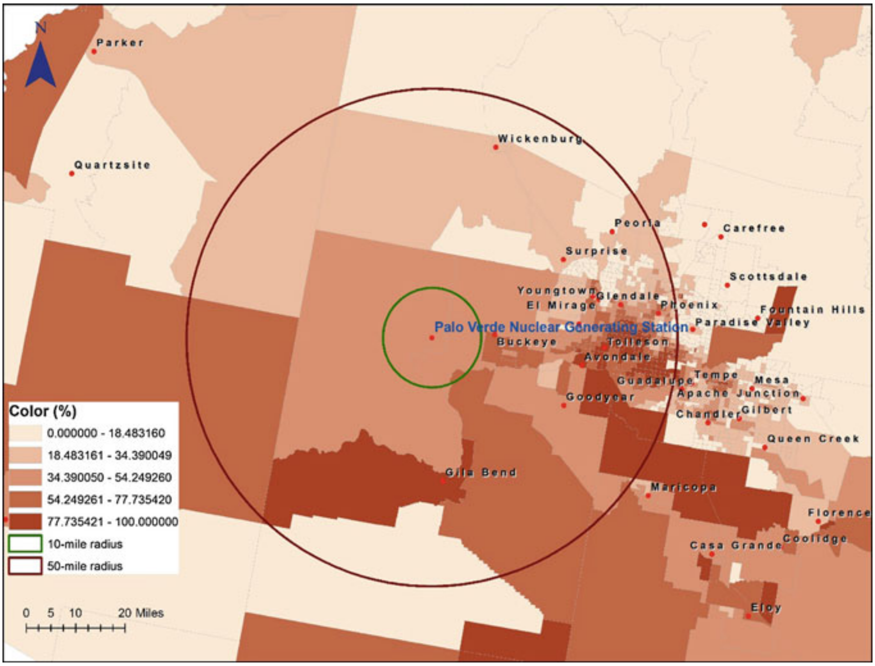

Fig. 2.1 Communities hosting the Palo Verde Nuclear Generating Station (PVNGS) within a 50-mile radius from the power plant

the controversial debate on the definition of impacted areas, this study uses the most legal definition of an impacted area, defined as an area within a 50-mile radius of an NPP. For example, a community living around a 50-mile radius from the Palo Verde Nuclear Generating Station (PVNGS) is depicted in Fig. 2.1.

2.2 Invisible Risks and Unknown Consequences

This session takes a closer look at the communities living around the nuclear power plants, to enhance understanding on environmental justice issues and current knowledge of consequences from constant exposure to low-level radiation.

2.2.1 Nuclear Power Plant Siting and Environmental Justice

Communities hosting the nuclear power plants are in fact embracing all different types of potential risks. There are certain types of risks that simply cannot be avoided, as discussed earlier in Chap. 1. The potential and inevitable risks include: core meltdown, contamination, nuclear radiation, and terrorist attack risks. NPPs utilize nuclear fuel rods containing fissionable materials and their destructive potentials are unpredictable in nature; their profound impacts on environments and humankind cannot be underestimated (Kyne 2014). Due to the potential destructive nature and unpredictable long-term impacts on environments and humankind, it is necessary for the Federal Government authorities to regulate all NPPs in the U.S. (Kyne 2014). Responsible regulatory authorities must monitor every step from selecting a plant site, the granting of construction licenses, and the warranting of operating a plant. Once an NPP is built within a community, that particular population in the area becomes the host community and begins to embrace the above-mentioned potential risks (Kyne 2014).

Given the fact that such nuclear power facilities have the potential to cause powerful destruction, governmental intervention plays a vital role in protecting human life and the environment. The Environmental Protection Agency (EPA) was established under the National Environmental Policy Act (NEPA) in 1970, with a mission to incorporate environmental protection policy into all federally sponsored projects. The EPA established goal is "to provide an environment where all people enjoy the same degree of protection from environmental and health hazards and equal access to the decision-making process to maintain a healthy environment in which to live, learn, and work (US EPA 2013)." To achieve this goal, the EPA promotes one of the key elements which is "public involvement." It is vital for communities that are likely to host a nuclear power plant to actively participate and engage in every step of environmental decision-making process, from site selection to issuing operating licenses.

Previously, when issuing the construction and operation licenses to all previous U.S. commercial nuclear power plants, environmental justice concepts were not incorporated, and the AEC has issued 126 NPP operating licenses without taking into account any environmental impacts or guidelines (US NRC 2004; Kyne 2014). During the AEC administration era, the agency struggled dual conflicting roles—on one hand, it was required to regulate the nuclear power industry; on the other hand, it was required to promote the industry growth. After receiving criticism for its dual roles and ineffectiveness, the AEC was dissolved in 1975. The NRC became its successor under the Energy Reorganization Act of 1974 (US NRC 2011; Kyne 2014). Since then, the NRC became the agency which has authority and responsibility in administering the licensing process (US NRC 2004; Kyne 2014). The licensing process in fact encourages public participation through adjudicatory, or courtroom-style hearings. In public meetings, proposed NPP projects are presented and their quality of design conform within the current existing environmental laws. Participants have opportunities to make comments on any design flaws, raise any environmental concerns and engage in debates on potential impacts (Mariottee 2006; Kyne 2014). There still remains the unanswered question with regard to public participation in the licensing process: Does the licensing process encourage public participation and if so, to what extend does the public participate; and to what extend the public concerns are taken into serious consideration by the NRC and other concerned authorities? Systematic studies on evaluation of public participation in nuclear power plant licensing processes are rarely found.

One notion is that there was a transformation taking place in the licensing process after 1992. Previously, all prospective owners of NPPs were required to seek the construction license first and then the operation license. The two steps were combined into one-step process in which the prospective owners or operators of NPPs could obtain both licenses. The one-step process was well received as it is shorter and provides encouragement to the prospective owners and operators to invest in NPPs. On the other hand, it also received criticism for placing increased constraints on public participation. The main barriers to public participation was observed as the creation of public contentions and its legitimate requirements to the ASLB. In public hearings, any public contentions must be decided by the three-person panel of NRC employees which consists of two technical experts and one attorney. Any citizen who would like to content an objection must bear substantial costs which include expert and attorney fees (an estimated cost of $100,000 to $500,000) who normally testify in support of the objecting party (Mariottee 2006; Kyne 2014). The barriers to public participation could undermine promotion of procedural equity which is essential for effective environmental decision-making processes and outcomes; thus, in turn, it could negatively affect the people living near NPPs (Kyne 2014).

In the history of US commercial nuclear power plant licensing, NPPs have not been well received by communities. There were many objections and resistance by the public who feared the unpredictable risks associated with nuclear power production. When nuclear power energy was introduced, there was a tension between two groups of scientists—those supporting the advantages of nuclear power and those who foresaw the risks associated with fuel rods, spent fuels, and radiation. During 1970s, the sentiments against nuclear power gained momentum and received significant public attention. Collective public action placed a haul or a delay of a number of the proposed NPPs at the time (Nuclear Heritage 2013; Kyne 2014). For example, there were more than 70,000 people who protested against nuclear power to Washington, DC, in May of 1979. For nuclear power energy, the protesters were not fully granted their constitutional rights of freedom of speech, but there were more than 1,414 people who protested against the construction of Seabrook NPP in New Hampshire, where they were arrested on May 2, 1997 (Nuclear Heritage 2013; Kyne 2014).

2.2.2 Embracing the Low-Level Radiation

NPPs regularly or from time to time release radioactive materials in gaseous or liquid forms from their normal operations, and from temporary shutdowns and abnormal situations such as a fuel-rod meltdown (Ottaviani and Wehe 1989).

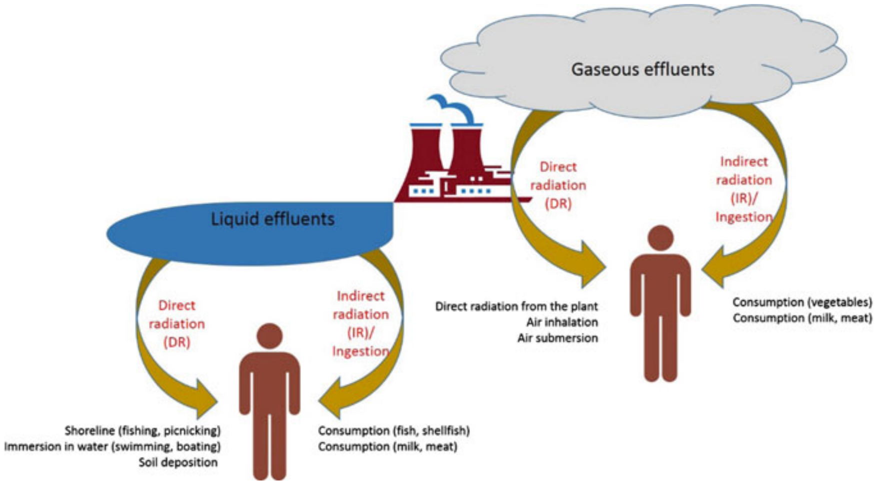

Fig. 2.2 Pathways for exposures to radiation from effluent releases from nuclear power plants. *Source* Adapted from (National Research Council (USA) & Committee on the Analysis of Cancer Risks in Populations near Nuclear Facilities 2012)

Individuals living in the host communities are involuntarily exposed to constant low-level radiation on a regular basis. In addition, these individuals involuntarily accept negative consequences from constantly being exposed to low-level radiation. Figure 2.2 depicts how an NPP releases gaseous and liquid radioactive effluents during normal operation.

According to the National Research Council (USA) and Committee on the Analysis of Cancer Risks in Populations near Nuclear Facilities (2012), there are mainly two radiation exposure pathways: external radiation and internal radiation. External radiation pathways include exposure to radionuclides that emit high-level radiation that could penetrate the human body. Possible sources are directly from a nuclear power facility, from ionizing radioactive particles present in the air, radioactive materials, and contaminated water body from radioactive liquid effluents from the nuclear power plant. Internal radiation pathway includes individuals receiving radiation thorough intake of radioactive materials into the body. For example, individuals could inhale air containing radioactive particles, or by consuming foods that were ingested with radiative materials.

2.2.3 *Consequence of Constant Exposure to Low-Level Radiation*

Many scientists have attempted to prove the casual relationships between low-level radiation and impacts on health. They have specified some negative health consequences that are related to permanent cellular damage and chronic illnesses, including various types of cancer, such as leukemia, thyroid, and other cancers (Ramana 2009). Some individuals could even face the worst consequence of premature death due to radiation (Denton 1987). Many researchers face great challenges in attempting to establish a correlation between the exposure to low-level radiation and the incidence of certain kinds of cancer (e.g., Bouges et al. 1999; Canu et al. 2008; Cardis et al. 1995, 2005; Sexton and Adgate 1999). The primary reason for this challenge is lack of data that could be used for investigations related to the attempted establishment in their studies. Some critical data that are not readily available for studies are data collected for the effects of prolonged exposure to low-level radiation, varying radiation doses, and health conditions of individuals prior to moving to the host communities (Kyne 2014).

In the existing studies, there was one study with a focus on cancer incident rates in the host communities before and after the NPP closure, after decommissioning (Mangano and Sherman 2013; US NRC 2013a). The two researchers focused their subject of the study on the Rancho Seco NPP, in Sacramento County, California, where they evaluated the population living in this particular host community. They collected two types of cancer incident rates—one consists of incident rates data collected during the last 2 years of the plant's operation in 1988 and 1989. The other included incident rates data of the communities two decades after decommissioning period. The study's findings show that cancer incident rates decline in 18 out of 31 categories. The study concluded that people in the communities who were exposed to prolonged low-level radiation were more likely to develop illnesses related to cancer (Mangano and Sherman 2013; Kyne 2014). The scientific study of the effects of exposure to radiation began with the injection of plutonium into 18 men, women, and children—performed in a U.S. hospital ward in 1945, and without informing the unwitting subjects of the potential risks and dangers—and has continued with present-day studies that have attempted to better understand the human body's reaction to various radioisotopes (Welsome 1999).

2.2.4 Incomplete Knowledge of Low-Level Radiation Consequences

It is surprising that nuclear power plants have been in existence and in operation for more than six decades, but the NRC does not have a solid and complete knowledge on negative health consequences for individuals exposed to low-level radiation for a long period of time. The National Research Council (USA) and Committee on the Analysis of Cancer Risks in Populations near Nuclear Facilities (2012) conducted a study design that would allow for the accurate assessing of cancer incident rates among populations living near NPPs. Their findings include that (1) many epidemiologic studies face challenges because of (a) lack of availability and quality of data on cancer mortality and incidence at geographic levels smaller than a county, (b) lack of quality data on nuclear facility effluent releases, (c) lack of population mobility risks factors, and (d) low expected statistical power; (2) different study designs such as risk projection models, ecologic studies, as cohort studies have strengths and limitations; and (3) effluent release, direct exposure, and meteorology data are needed to better understand what effect radiation has, depending on distance and direction from a nuclear power plant. The committee recommends that the NRC should carry out an epidemiologic study of cancer risks on two areas: (1) an ecologic study of multiple cancer types and (2) case–control study of cancers in children born near the nuclear facility.

In their second phase (National Research Council (USA) and Committee on the Analysis of Cancer Risks in Populations near Nuclear Facilities 2014), seven nuclear facilities were selected for the pilot study of cancer risks:

1. Dresden Nuclear Power Station, Morris, Illinois,
2. Millstone Power Station, Waterford, Connecticut,
3. Oyster Creek Nuclear Generating Station, Forked River, New Jersey,
4. Haddam Neck Plant, Haddam Neck, Connecticut,
5. Big Rock Point Nuclear Plant, Charlevoix, Michigan,
6. San Onofre Nuclear Generating Station, San Clemente, California, and
7. Nuclear Fuel Services, Erwin, Tennessee.

As recommended in the Phase I study, the committee will carry out two studies: a case–control and an ecologic study in Phase II (National Research Council (USA) and Committee on the Analysis of Cancer Risks in Populations near Nuclear Facilities 2014). The first study examines cancer types of all ages living within 30-mile radius from the nuclear power plant.

(1) "Do cancer incidence and mortality vary by proximity to nuclear facilities?
(2) Does cancer incidence or mortality reflect patterns of radiation exposure associated with the nuclear facility? (National Research Council (USA) and Committee on the Analysis of Cancer Risks in Populations near Nuclear Facilities 2014)."

In the latter study, the subjects of the study are children younger than 15 years of age and their mother lived in areas within a 30-mile radius. The study attempts to hypothesize that children born by mothers living closer to the nuclear facilities are more likely to develop cancer than their counterparts who live further away, from the 30-mile radius. The study's findings are expected to provide answers to the following two research questions.

(1) "Is a mother's residential proximity to a nuclear facility at time of delivery associated with cancer in her children?
(2) Is estimated radiation exposure during pregnancy, early infancy, or childhood associated with childhood cancer occurrence? (National Research Council (USA) and Committee on the Analysis of Cancer Risks in Populations near

> Nuclear Facilities 2014)" The current estimated time frame to complete this pilot study was 16 months, another 30 months to assess feasibility of nationwide study, and another 30 months to estimate the risk in a nationwide study; a total of 66 months is projected.

Above all, the agency who is responsible and accountable for regulating the nuclear power industry does not have a compete knowledge on constant exposure to low-level radiation. Without a complete knowledge, the authorities seem being blindfolded and walking on the regulation pathway without any direction. As a result, this has placed individuals living in the host communities at greater risk.

2.2.5 Nuclear Power Facilities Living Longer Than Human Average Longevity

The longevity of a commercial NPP is about 120 years, which normally counts the day operation began until the day its decommission is successfully completed, and includes 60 years from inception to the decommission; 50 years to cool down the reactor after its permanent shutdown; and 40 to 60 years to decommission the plant (Green Peace 2010; Kyne 2014). In general, the existence of nuclear power plants in host communities could be more than 120 years (Kyne 2014). Activities to remove an NPP after it has been shut down requires regulated monitoring because of the removal of several thousand tons of radioactive materials, such as spent fuel rods. Thus, NRC has adopted three advanced strategies to decommission an NPP:

(1) DECON, or decommissioning strategies;
(2) SAFSTOR, or deferred dismantling; and,
(3) ENTOMB, or the permanent encasing on site of radioactive contaminants (US NRC 2013a; Kyne 2014).

Among the three strategies, entombing includes permanently encasing the radioactive materials. In some cases, it requires several years to monitor both underground water and soil contamination. Hallam Nuclear Power Plant in Nebraska operated for a short time period and later it was decommissioned in 1971. It was entombed and the radioactive contaminated materials were buried underground. Due to the risks for underground water contamination, the Nebraska Department of Health has been monitoring possible underground water contamination and radiation. The monitoring will last for a period of 119 years, until 2090 (Nebraska Energy Quarterly 1997; Kyne 2014).

It is evident that after an NPP is introduced to the host communities, the individuals living in the area have to bear the risks of exposure to low-level radiation, and face health risks and long-term negative impacts on their environment (Kyne 2014).

2.3 Data and Research Methods

2.3.1 Study Questions

The primary goal of this chapter is to understand the communities hosting nuclear power plants. The understanding is necessary for effectively managing nuclear emergency and response. To achieve the primary goal, the following research questions are determined as follows:

(1) What are demographic characteristics of the individuals living in the communities hosting nuclear power plants in 1990, 2000, and 2010?
(2) Do the demographic characteristics vary with proximity to the nuclear power plants?
(3) Do the demographic characteristics vary from urban to non-urban areas?
(4) Do the demographic characteristics vary at individual nuclear power plants?
(5) Did the demographic characteristics change between 1900 and 2000, and between 2000 and 2010?

2.3.2 Study Variables

This chapter attempts to investigate the demographic characteristics of populations living in either of the two study areas described above. The demographic variables selected for this study purpose include both racial/ethnic and socioeconomic variables.

First, the racial/ethnic variables included the categories White, Black, Asian, Hispanic, Native American, Other, and Color. They are defined as follows:

(1) Percent White as percent of all non-Hispanic Whites;
(2) Percent Black is as percent of non-Hispanic Blacks or African Americans;
(3) Percent Asian as percent of Asian, and Native Hawaiian or Other Pacific Islander;
(4) Percent Native American as percent of American Indian or Alaska Native;
(5) Percent Other as percent of Some Other Race whose are not included in the White, Black, or African American, American Indian or Alaska Native, Asian, and Native Hawaiian or Other Pacific Islander race categories;
(6) Percent Color as percent of all other races except non-Hispanic Whites; and
(7) Percent Hispanic as percent of people who are Hispanic origin.

Second, the socioeconomic variables selected for inclusion were as follows:

(1) renter-occupied housing,
(2) unemployment rate,
(3) percent living in poverty,

(4) mean household income, and
(5) percent composition at the census-tract level.

The construction of the study variables is depicted in Appendix A (Table A.1).

In addition to the above-mentioned demographic variables, this study also includes distance from the NPP in order to analyze proximity-based disparities in any of the given study variables. The distance from the NPP was measured in Euclidean distance, in miles, between the census-tract center point and the NPP.

2.3.3 Study Data

To answer the research questions above, multiple datasets were obtained. First, for demographic characteristics, the US Census Bureau and GeoLytics datasets are acquired:

(1) US Census 1990, long form, normalized to 2010 census-tract boundaries (GeoLytics 2012b);
(2) US Census 2000, long form, normalized to 2010 census-tract boundaries (GeoLytics 2012a); and
(3) US Census 2010/American Community Survey, 5-year estimate (GeoLytics 2012c).

The 1990 and 2000 data containing census-tract level surveys are normalized to those of 2010 census boundaries. This normalization allows for the comparison of study variables across the study years. The geographical unit of analysis in this study is the census tract. The selected datasets for 1990, 2000, and 2010 contain racial and ethnic subgroups and socioeconomic data.

In order to conduct spatial analyses including tracking the changes in study variables across the study years, this study used the TIGER/Line shapefiles and the 2010 US Census Summary File 1 Demographic Profile (DP1) for the USA and Puerto Rico from the US Census Bureau's Web site. (The US Census Bureau 2010b). The selected study variables were merged with the selected shapefiles in the ArcGIS 10.2 program.

Geographical locations of the 99 nuclear reactors which are currently in operation were created in the shapefiles to conduct spatial analysis. Information was obtained from the NRC's Web site (NRC 2012) in order to create information on the following: geographical locations of the reactors, data on reactor type and containment type, design type, docket number, licensee, operating license issue date, commercial operation start date, renewed operation license, issue date, and operating license expiration date. However, since the September 11, 2011 event, the NRC did not provide latitude and longitude information for safety reason. To obtain latitude and longitude information for individual NPPs, individual planta was located in the Google Earth program and the XY coordinates were obtained manually.

2.3.4 Study Methods

This study covers populations living within a 50-mile radius of an NPP and considers this distance to define a host community. Those living at a distance greater than a 50-mile radius from an NPP are thus not considered a host community, for the purposes of this study. The selection of a 50-mile distance reflects the need to consider two emergency zones, namely the plume exposure pathway zone, which includes a radius of approximately 10 miles from the reactor site, and the ingestion exposure pathway zone, which has a radius of approximately 50 miles from the reactor site as defined by the NRC (US NRC 2013b).

However, the NRC's use of the 50-mile distance is considered to be controversial, given that more than 37 environmental and civic organizations argued that the 50-mile distance is not adequate to allow for full emergency preparedness, in reference to the Chernobyl and Fukushima Daiichi accidents (NIRS 2013). The selection of a 50-mile distance reflects the legal definition and boundaries of emergency zones. To determine the host communities surrounding an NPP, the census tracts that are within a 50-mile distance from the power plant are included as host communities (Fig. 2.3).

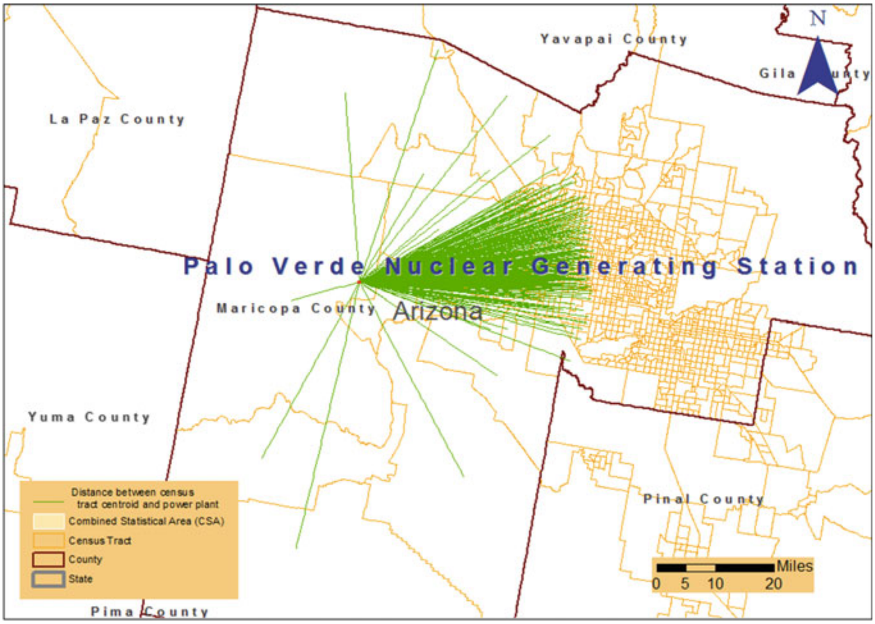

Fig. 2.3 Distance between census-tract centroid and Palo Verde Nuclear Generating Station within 50-mile distance; *Source* (Kyne 2014)

2.4 Overall Demographic Composition by Distance

This section explains findings of demographic characteristics in communities hosting 61 nuclear power plants. As stated, the overall population is the sum of population at all census tracts living around the nuclear power plants within a 50-mile radius. In some locations, when the two power plants are located close to each other, or a distance less than 50 miles from one another, some census tracts could be included in both host communities for each of the power plants. In such cases, the census tracts are counted only once. In other words, the total population living in the communities hosting the 61 power plants include only those individuals living in unique census tracts. To understand the disparities, the study measures the socio-demographic characteristics of the host communities by the six distance categories, namely 0–10 miles from the nearest NPP, 11–20 miles, 21–30 miles, 31–40 miles, 41–50 miles, 0–50 miles, and those more than 50 miles from the nearest NPP (outside), included in the study periods, 1990, 2000, and 2010. Population living in those communities outside of a 50-mile radius within the state are also described in the table (outside areas) to compare the demographic characteristics of population between host communities and non-host communities.

There are 87.47 million in 2010, 82.93 million in 2000, and 75.56 million individuals living in areas within a 50-mile radius from the 61 nuclear power plants (Tables 2.1, 2.2, and 2.3). Looking at each racial and ethnic group, the total population consists of 71% White, 17% Black, 4.4% Asian, 6.9% Other, 13.18% Hispanic, and 36.32% Color. When comparing with the outside areas in 2010, the 71% White were in host communities, whereas there are 75% White in outside areas. This implies that the present of White individual is higher in outside areas than their counterparts in the host communities. In other words, more White people prefer to live in non-host communities. In contrast, more Black people tend to live in host communities. There are 17.30% Black in the host communities, whereas only 10.55% of their counterparts present in outside areas. Unlike Black, fewer Hispanics are found in the host communities. There are 13.18% Hispanic living in the host communities, whereas 16% of their counterparts live in outside areas. Findings are similar in other racial groups including Asian, Native Americans, and the "Other" category. "People of Color" is a category that includes the total population excluding non-Hispanic Whites (see Appendix A, Table A.1) and was observed as a more prevalent racial group among communities within a 50-mile radius of an NPP (36%) than their counterparts living among communities in outside areas (35%) (Table 2.1). Findings indicate that the presence of People of Color in the outside areas was slightly lower than the presence of their counterparts in the host communities. The following observations on populations living in the host communities in comparison with the communities living in the outside areas could be made from the study findings: They (1) earn higher than the average household income; (2) are more likely to live in renter-occupied housing units;

Table 2.1 Demographic composition according to area, sorted by distance from any one of the 61 US-based commercial NPPs, based on 2010 American community survey data

	0–10	11–20	21–30	31–40	41–50	0–50	#Outside
Tract	881	3,123	5,902	7,267	4,452	21,625	51,432
Tract area (sq. mile)	17,411	53,061	77,062	89,543	49,638	286,714	3,510,028
Total population	3,785,622	12,924,633	24,002,206	29,428,636	17,329,084	87,470,176	216,495,088
White	3,149,990	10,331,676	17,654,848	20,074,272	10,964,530	62,175,316	162,720,384
Black	403,053	1,574,326	4,038,444	5,493,675	3,623,037	15,132,535	22,846,216
Asian	76,117	347,859	782,670	1,464,925	1,174,769	3,846,340	10,830,826
Native American	9,872	38,608	69,544	110,421	59,304	287,749	2,192,716
Others	146,590	632,164	1,456,700	2,285,341	1,507,444	6,028,239	17,904,950
Hispanic	309,223	1,287,201	2,964,844	4,326,143	2,640,485	11,527,896	36,199,636
Color	844,011	3,417,169	8,130,174	11,683,426	7,698,411	31,773,192	75,619,312
Female	1,922,927	6,609,058	12,335,718	15,167,198	8,940,031	44,974,931	109,591,612
Old (65+ years)	419,393	1,372,779	2,302,602	2,648,012	1,354,474	8,085,141	20,575,376
Kid (<5 years)	25,838	100,919	260,071	346,928	234,982	968,684	1,533,545
White (%)	83.21	79.94	73.56	68.21	63.27	71.08	75.16
Black (%)	10.65	12.18	16.83	18.67	20.91	17.30	10.55
Asian (%)	2.01	2.69	3.26	4.98	6.78	4.40	5.00
Native American (%)	0.26	0.30	0.29	0.38	0.34	0.33	1.01
Others (%)	3.87	4.89	6.07	7.77	8.70	6.89	8.27
Hispanic (%)	8.17	9.96	12.35	14.70	15.24	13.18	16.72
Color (%)	22.30	26.44	33.87	39.70	44.42	36.32	34.93
Female (%)	50.80	51.14	51.39	51.54	51.59	51.42	50.62
Old (65+ years) (%)	13.31	13.29	13.04	13.19	12.35	13.00	12.64
Kid (<5 years) (%)	6.41	6.41	6.44	6.32	6.49	6.40	6.71

(continued)

Table 2.1 (continued)

	0–10	11–20	21–30	31–40	41–50	0–50	#Outside
Native-born (%)	92.57	90.93	88.08	84.89	79.61	85.94	87.82
Renter housing units (%)	21.72	25.60	28.71	33.24	34.81	30.66	28.80
College degree or higher (%)	27.96	29.86	29.46	30.46	30.16	29.93	27.07
Unemployment (%)	7.19	7.33	8.02	8.43	8.21	8.06	7.87
Poverty (%)	10.10	11.39	12.98	13.72	13.53	12.98	14.16
Mean household income ($)	74,831	75,869	73,736	75,122	76,236	75,057	69,179

Table 2.2 Demographic composition according to area, sorted by distance from any one of the 61 US-based commercial NPPs, based on 2000 American community survey data normalized to 2010 US census boundaries

	0–10	11–20	21–30	31–40	41–50	0–50	#Outside
Tract	881	3,123	5,902	7,267	4,452	21,625	51,432
Tract area (sq. mile)	17,411	53,061	77,062	89,543	49,638	286,714	3,510,028
Total population	3,320,806	11,798,208	22,752,148	28,365,748	16,693,309	82,930,216	198,491,696
White	2,845,596	9,728,702	17,187,364	19,820,268	10,866,363	60,448,296	150,905,424
Black	317,882	1,344,595	3,741,738	5,233,932	3,497,843	14,135,990	20,225,750
Asian	42,950	218,981	533,037	1,084,885	840,199	2,720,052	7,830,550
Native American	10,232	40,587	75,776	118,638	61,272	306,505	2,141,484
Others	104,272	465,182	1,214,213	2,108,042	1,427,585	5,319,294	17,388,556
Hispanic	165,809	803,233	2,132,320	3,296,326	2,085,288	8,482,976	26,755,504
Color	571,357	2,540,502	6,766,977	10,081,858	6,765,774	26,726,468	60,181,296
Female	1,690,846	6,038,254	11,738,862	14,667,990	8,638,993	42,774,942	100,730,780
Old (65+ years)	365,327	1,255,586	2,227,851	2,563,851	1,323,869	7,727,279	18,533,455
Kid (<5 years)	25,705	106,589	301,085	415,214	286,593	1,133,983	1,668,418
White (%)	85.69	82.46	75.54	69.87	65.09	72.89	76.03
Black (%)	9.57	11.40	16.45	18.45	20.95	17.05	10.19
Asian (%)	1.29	1.86	2.34	3.82	5.03	3.28	3.95
Native American (%)	0.31	0.34	0.33	0.42	0.37	0.37	1.08
Others (%)	3.14	3.94	5.34	7.43	8.55	6.41	8.76
Hispanic (%)	4.99	6.81	9.37	11.62	12.49	10.23	13.48
Color (%)	17.21	21.53	29.74	35.54	40.53	32.23	30.32
Female (%)	50.92	51.18	51.59	51.71	51.75	51.58	50.75
Old (65+ years) (%)	12.84	12.91	12.96	12.94	12.18	12.78	12.28
Kid (<5 years) (%)	8.09	7.93	8.05	7.93	8.19	8.02	8.25

(continued)

Table 2.2 (continued)

	0–10	11–20	21–30	31–40	41–50	0–50	#Outside
Native-born (%)	94.71	92.87	89.78	86.75	81.53	87.72	89.46
Renter housing units (%)	22.79	26.59	30.42	35.42	37.35	32.64	30.00
College degree or higher (%)	23.76	26.02	25.59	26.41	25.77	25.89	23.77
Unemployment (%)	4.76	4.85	5.71	6.02	6.40	5.79	5.77
Poverty (%)	8.90	9.43	11.59	12.38	12.95	11.72	12.65
Mean household income ($)	73,480	75,633	73,474	74,511	75,395	74,520	68,904

Table 2.3 Demographic composition according to area, sorted by distance from any one of the 61 US-based commercial NPPs, based on 1990 American community survey data normalized to 2010 US census boundaries

	0–10	11–20	21–30	31–40	41–50	0–50	#Outside
Tract	881	3,123	5,902	7,267	4,452	21,625	51,432
Tract area (sq. mile)	17,411	53,061	77,062	89,543	49,638	286,714	3,510,028
Total population	2,872,653	10,412,267	20,904,464	26,161,414	15,209,935	75,560,736	173,148,624
White	2,547,599	9,011,480	16,755,732	19,829,114	10,838,429	58,982,352	140,844,256
Black	261,483	1,113,991	3,288,618	4,674,866	3,189,857	12,528,815	17,401,612
Asian	25,874	131,508	337,458	668,567	514,220	1,677,627	5,549,255
Native American	9,013	30,139	58,238	95,796	47,295	240,481	1,774,563
Others	28,784	124,947	464,452	893,046	620,151	2,131,380	7,578,717
Hispanic	89,271	395,405	1,412,975	2,101,466	1,351,832	5,350,949	16,549,152
Color	381,220	1,659,713	5,037,307	7,364,445	4,983,126	19,425,812	40,859,180
Female	1,460,436	5,366,463	10,849,682	13,599,014	7,906,815	39,182,411	88,354,808
Old (65+ years)	321,785	1,144,949	2,194,278	2,595,350	1,357,899	7,613,219	17,441,976
Kid (<5 years)	22,867	96,001	284,830	398,670	272,221	1,075,803	1,554,033
White (%)	88.68	86.55	80.15	75.80	71.26	78.06	81.34
Black (%)	9.10	10.70	15.73	17.87	20.97	16.58	10.05
Asian (%)	0.90	1.26	1.61	2.56	3.38	2.22	3.20
Native American (%)	0.31	0.29	0.28	0.37	0.31	0.32	1.02
Others (%)	1.00	1.20	2.22	3.41	4.08	2.82	4.38
Hispanic (%)	3.11	3.80	6.76	8.03	8.89	7.08	9.56
Color (%)	13.27	15.94	24.10	28.15	32.76	25.71	23.60
Female (%)	50.84	51.54	51.90	51.98	51.98	51.86	51.03
Old (65+ years) (%)	12.63	12.71	13.10	13.09	12.53	12.91	12.38
Kid (<5 years) (%)	8.75	8.62	8.66	8.53	8.53	8.59	8.93

(continued)

Table 2.3 (continued)

	0–10	11–20	21–30	31–40	41–50	0–50	#Outside
Native-born (%)	96.32	95.18	92.06	90.39	86.66	90.99	92.52
Renter housing units (%)	24.68	28.03	31.89	36.97	38.74	34.20	31.33
College degree or higher (%)	18.52	21.32	21.01	22.12	21.24	21.39	19.87
Unemployment (%)	5.55	5.20	6.20	6.60	6.60	6.26	6.34
Poverty (%)	9.60	9.70	12.02	12.62	12.29	11.87	13.66
Mean household income ($)	64,953	68,022	66,607	67,859	69,318	67,717	61,101

(3) are more likely to hold college degree or higher; (4) are less likely to be employed; and (5) are less likely to be native-born citizens. However, findings do not show any significant differences between the two areas in age or gender study variables. Similar demographic patterns are observed in the years 2000 (Table 2.2) and 1990 (Table 2.3).

Looking into proximity-based disparities in demographic characteristics, the findings indicate that there is a negative association between the percent White and the distance. In the 2010 data, the percent of White population was observed as 83.21, 79.94, 73.56, 68.21, and 63.27%, respectively, in the 0–10 miles, 11–20 miles, 21–30 miles, 31–40 miles, and 41–50 mile categories, respectively (Table 2.1). In contrast, the positive association is observed between the percent in other racial groups, namely Black, Asian, Hispanic, and Native American, and their distance from the NPP. Similarly, the positive association is observed between the percent of socio-demographic study variables, namely poverty, unemployment rate, education attainment, and household income (Table 2.1, Fig. 2.4). Similar patterns in the study variables are observed in the US Census data for the years 2000 (Table 2.2) and 1990 (Table 2.3).

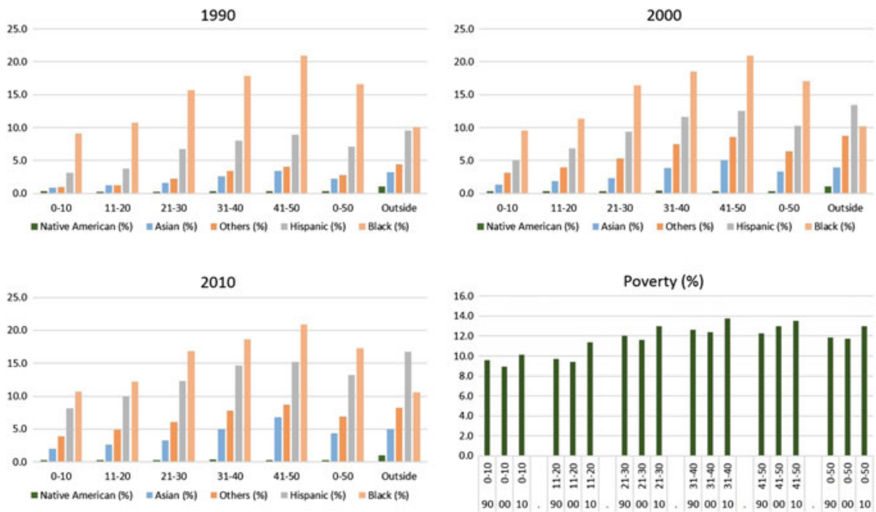

Fig. 2.4 Demographic trends (race/ethnicity) in the areas surrounding any one of the 61 US-based commercial NPPs, as sorted by distance

2.5 Hosting Communities in Urban and Non-urban Areas

To define the boundaries of metropolitan areas, this study used the Combined Statistical Areas (CSAs) 2010 TIGER Shape file (The US Census Bureau 2010b). The Shape file consists of metropolitan statistical areas which are created based on urbanized areas (50,000 people or more) and micropolitan statistical areas, which are based on urban clusters (between 10,000 and fewer than 50,000 people) (The US Census Bureau 2010a).

In 2010, out of the 87 million people living within a 50-mile radius of an NPP, 77 million lived in a metropolitan area (Table 2.4). Within that same group, those living within a 50-mile radius of an NPP, there was a higher percent Black, Asian, and Hispanic in metropolitan areas as compared to non-metropolitan areas. A higher percent of Color people, 37%, lived in metropolitan areas than that lived in non-metropolitan areas, 31%. There was a pattern in the socioeconomic data, such that metropolitan areas included more people with a college degree or who had completed some other form of higher education, a greater percentage of unemployed individuals, and fewer people living in poverty. Further, the mean household income was higher than as compared to demographically similar households in non-metropolitan areas. Similar patterns were observed in the US Census data for the years 2000 (Table 2.5) and 1990 (Table 2.6), respectively.

Over the past three decades, in communities sited within a 50-mile radius of an NPP, there has been a sharp decrease in the percent White among the population, with a compensating dramatic increase in the percent Hispanic and percent Color (Fig. 2.5), in both metropolitan and non-metropolitan areas. This same pattern is observed in non-metropolitan areas when considering the demographic data for the outlying areas.

2.6 Hosting Communities at Individual Nuclear Power Plants

In this section, the demographic characteristics of the communities surrounding individual NPPs in areas within a 10-mile radius and within a 50-mile radius are discussed. Second, the percent change in total population of the communities in proximity to an individual NPP during the periods 1990–2000 and 2000–2010 is listed.

Analysis and discussion of the socio-demographic composition of the host communities consider those populations living in communities within a 10-mile radius and a 50-mile radius of a NPP, respectively. First, each NPP was ranked according to the total population living within a 10-mile radius according to 2010 US Census data. The total such population varies from just 2,654, near South Texas Project, Texas, to as much as 257,462, at Limerick Generating Station, Pennsylvania (Table 2.7)—approximately 0.06% of the total US population lives within a 10-mile radius of the Limerick Generating Station. The ten NPPs with the largest population living in such close proximity as of 2010 were as follows:

Table 2.4 Demographic composition in metropolitan areas within a 50-mile radius of any one of the 61 US commercial NPPs, based on 2010 American community survey data

	Urban	Non-urban	Urban outside	Non-urban outside
Tract	19,222	2,403	35,148	16,284
Tract area (sq. mile)	173,650	113,064	764,061	2,745,968
Total population	77,488,104	9,982,079	152,552,224	63,942,864
White	54,565,688	7,609,628	111,465,152	51,255,228
Black	13,487,840	1,644,695	17,367,044	5,479,172
Asian	3,663,882	182,458	8,893,478	1,937,348
Native American	230,165	57,584	1,038,965	1,153,751
Others	5,540,525	487,714	13,787,588	4,117,362
Hispanic	10,477,473	1,050,423	27,627,094	8,572,543
Color	28,723,434	3,049,757	57,342,840	18,276,470
White (%)	70.42	76.23	73.07	80.16
Black (%)	17.41	16.48	11.38	8.57
Asian (%)	4.73	1.83	5.83	3.03
Native American (%)	0.30	0.58	0.68	1.80
Others (%)	7.15	4.89	9.04	6.44
Hispanic (%)	13.52	10.52	18.11	13.41
Color (%)	37.07	30.55	37.59	28.58
Female (%)	51.49	50.83	50.79	50.22
Old (65+ years) (%)	12.88	13.96	11.92	14.38
Kid (<5 years) (%)	6.37	6.65	6.80	6.49
Native-born (%)	84.99	93.34	85.80	92.62
Renter housing units (%)	31.29	25.94	30.40	25.35
College degree or higher (%)	30.93	22.02	29.28	21.86
Unemployment (%)	8.12	7.49	7.94	7.69
Poverty (%)	12.71	15.09	13.51	15.71
Mean household income ($)	76,850	61,118	73,392	59,404

Table 2.5 Demographic composition in metropolitan areas within a 50-mile radius of any one of the 61 US commercial NPPs, based on 2000 American community survey data

	Urban	Non-urban	Urban outside	Non-urban outside
Tract	19,222	2,403	35,148	16,284
Tract area (sq. mile)	173,650	113,064	764,061	2,745,968
Total population	73,925,584	9,004,636	138,833,968	59,657,720
White	53,513,884	6,934,410	103,039,168	47,866,268
Black	12,672,128	1,463,862	15,169,283	5,056,467
Asian	2,601,777	118,275	6,327,916	1,502,634
Native American	257,619	48,886	1,033,967	1,107,517
Others	4,880,127	439,167	13,263,712	4,124,844
Hispanic	7,868,239	614,737	20,485,020	6,270,484
Color	24,394,302	2,332,166	45,308,664	14,872,632
White (%)	72.39	77.01	74.22	80.23
Black (%)	17.14	16.26	10.93	8.48
Asian (%)	3.52	1.31	4.56	2.52
Native American (%)	0.35	0.54	0.74	1.86
Others (%)	6.60	4.88	9.55	6.91
Hispanic (%)	10.64	6.83	14.76	10.51
Color (%)	33.00	25.90	32.64	24.93
Female (%)	51.64	51.07	50.87	50.47
Old (65+ years) (%)	12.64	13.93	11.53	14.03
Kid (<5 years) (%)	8.04	7.89	8.43	7.83
Native-born (%)	86.80	95.32	87.55	93.91
Renter housing units (%)	33.52	25.66	32.07	25.64
College degree or higher (%)	26.69	19.29	25.87	18.92
Unemployment (%)	5.81	5.55	5.63	6.11
Poverty (%)	11.51	13.51	11.90	14.41
Mean household income ($)	76,287	60,094	73,621	58,173

Table 2.6 Demographic composition in metropolitan areas within a 50-mile radius of any one of the 61 US commercial NPPs, based on 1990 American community survey data

	Urban	Non-urban	Urban outside	Non-urban outside
Tract	19,222	2,403	35,148	16,284
Tract area (sq. mile)	173,650	113,064	764,061	2,745,968
Total population	67,602,272	7,958,464	120,016,720	53,131,904
White	52,568,548	6,413,805	96,121,016	44,723,232
Black	11,264,808	1,264,007	12,908,319	4,493,294
Asian	1,598,934	78,693	4,243,576	1,305,679
Native American	201,596	38,885	842,528	932,035
Others	1,968,337	163,043	5,901,096	1,677,621
Hispanic	5,051,194	299,755	12,640,686	3,908,466
Color	17,752,876	1,672,936	30,344,224	10,514,956
White (%)	77.76	80.59	80.09	84.17
Black (%)	16.66	15.88	10.76	8.46
Asian (%)	2.37	0.99	3.54	2.46
Native American (%)	0.30	0.49	0.70	1.75
Others (%)	2.91	2.05	4.92	3.16
Hispanic (%)	7.47	3.77	10.53	7.36
Color (%)	26.26	21.02	25.28	19.79
Female (%)	51.89	51.55	51.10	50.87
Old (65+ years) (%)	12.79	13.94	11.62	14.12
Kid (<5 years) (%)	8.57	8.69	9.02	8.74
Native-born (%)	90.24	97.37	91.02	95.91
Renter housing units (%)	35.05	27.20	33.54	26.73
College degree or higher (%)	22.01	15.96	21.74	15.63
Unemployment (%)	6.29	5.94	6.10	6.93
Poverty (%)	11.51	15.00	12.45	16.42
Mean household income ($)	69,394	53,429	65,690	50,809

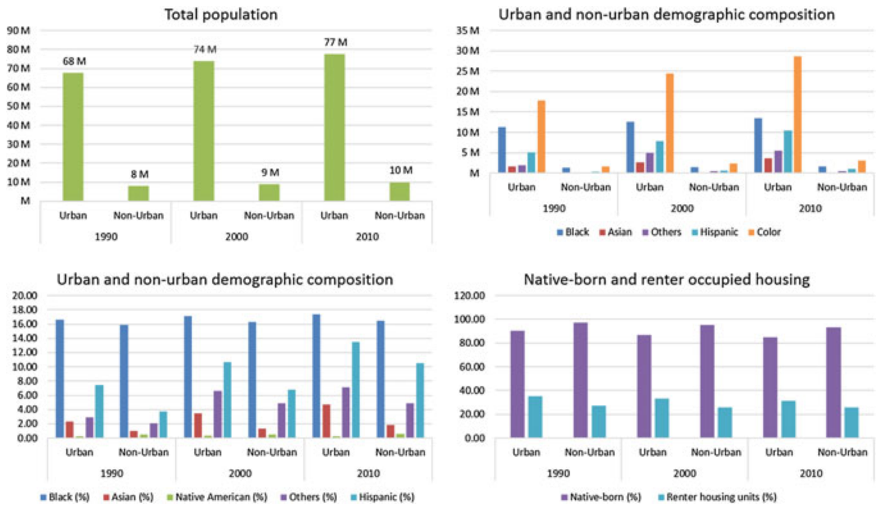

Fig. 2.5 Demographic trends (race/ethnicity) in the areas surrounding any one of the 61 US-based commercial NPPs, as sorted by urban and non-urban areas

(1) Limerick Generating Station, Pennsylvania, 257,462; (2) FitzPatrick Nuclear Power Plant, New York, 253,977; (3) St. Lucie Plant, Florida, 209,961; (4) Catawba Nuclear Station, South Carolina, 200,869; (5) Three Mile Island Nuclear Station, Pennsylvania, 191,325; (6) McGuire Nuclear Station, North Carolina, 188,937; (7) Turkey Point Nuclear Generating, Florida, 147,705; (8) Surry Nuclear Power Station, Virginia, 133,856; (9) Oyster Creek Nuclear Generating Station, New Jersey, 128,893; and (10) Seabrook Station, New Hampshire, 120,876. The three NPPs with the smallest total populations living within a 10-mile radius as of 2010 were as follows: (1) South Texas Project, Texas, 2,654; (2) Palo Verde Nuclear Generating Station, Arizona, 3,090; and (3) Columbia Generating Station, Washington, 6,007 (Table 2.7).

In 2000, among the ten NPPs with the largest such populations as of 2010, Beaver Valley Power Station, Pennsylvania, and Millstone Power Station, Connecticut, replaced Turkey Point Nuclear Generating, Florida, and Oyster Creek Nuclear Generating Station, New Jersey (Table 2.7); the three NPPs with the smallest such populations were the same in 2000 (Table 2.7). In 1990, among the top ten such NPPs as of 2000, Oyster Creek Nuclear Generating Station, New Jersey, replaced Millstone Power Station, Connecticut, while the bottom-three NPPs in terms of such population again were unchanged (Table 2.7).

The total population living within a 50-mile radius of an NPP in 1990, 2000, and 2010 are also depicted in Table 2.8. The total population of communities sited in such areas ranged between 111,113, and 15 million (Table 2.8); approximately 5% of the total US population as of 2010 lived within a 50-mile radius of Indian Point Nuclear Generating Station. The ten NPPs with the largest total population living within a 50-mile radius were as follows: (1) Indian Point Nuclear Generating,

Table 2.7 Total population living in census tracts within a 10-mile radius of a NPP as of 2010, as measured from census-tract centroid point to NPP

Index	Plant name	State	No. of tract	Tract area	Total population (0–10 mile)		2010	Rank
			(10-mile)	(sq. mile)	1990	2000		2010
1	Browns Ferry	Alabama	10	302	36,259	38,640	40,292	31
2	Farley	Alabama	5	358	15,104	15,882	17,021	50
3	Palo Verde	Arizona	1	120	1,365	2,112	3,090	60
4	Arkansas Nuclear	Arkansas	8	196	32,038	37,734	43,212	29
5	Diablo Canyon	California	7	358	39,157	40,444	27,776	40
6	Millstone	Connecticut	32	266	118,811	115,203	118,025	11
7	Saint Lucie	Florida	35	234	132,150	157,349	206,961	3
8	Turkey Point	Florida	26	208	89,348	99,529	147,705	7
9	Hatch	Georgia	3	333	9,459	10,524	10,422	55
10	Vogtle	Georgia	2	325	6,629	7,929	8,333	58
11	Braidwood	Illinois	10	327	28,159	32,863	35,921	32
12	Byron	Illinois	5	300	19,736	22,901	23,750	43
13	Clinton	Illinois	4	254	13,021	13,049	12,773	51
14	Dresden	Illinois	17	251	44,647	54,839	73,784	18
15	La Salle	Illinois	3	188	10,831	11,165	12,195	52
16	Quad Cities	Illinois	7	272	33,742	32,764	32,223	35
17	Duane Arnold	Iowa	22	291	77,265	90,277	95,814	14
18	Wolf Creek	Kansas	3	654	8,404	8,865	8,587	57
19	River Bend	Louisiana	5	239	16,273	18,311	18,786	49
20	Waterford	Louisiana	18	285	61,978	67,869	73,071	19
21	Calvert Cliffs	Maryland	10	258	33,438	48,206	48,285	26
22	Pilgrim	Massachusetts	15	453	59,169	66,086	69,440	20
23	D.C. Cook	Michigan	16	183	51,729	53,837	53,507	25

(continued)

Table 2.7 (continued)

Index	Plant name	State	No. of tract (10-mile)	Tract area (sq. mile)	Total population (0–10 mile) 1990	2000	2010	Rank 2010
24	FermiFermi	Michigan	24	268	78,888	82,873	85,991	15
25	Palisades	Michigan	8	183	34,133	34,594	33,432	34
26	Monticello	Minnesota	8	308	28,856	42,437	56,001	23
27	Prairie Island	Minnesota	5	226	22,549	24,295	25,260	41
28	Grand Gulf	Mississippi	4	662	13,756	14,443	12,168	53
29	Callaway	Missouri	2	237	8,124	10,726	11,642	54
30	Cooper	Nebraska	3	670	11,078	10,205	9,770	56
31	Fort Calhoun	Nebraska	5	173	15,687	17,820	18,933	48
32	Seabrook	New Hampshire	30	270	101,342	117,140	120,876	10
33	Hope Creek	New Jersey	15	332	34,738	40,224	47,275	27
34	Oyster Creek	New Jersey	29	287	91,665	114,293	128,893	9
35	Salem	New Jersey	15	332	34,738	40,224	47,275	28
36	FitzPatrick	New York	55	292	229,882	242,165	253,977	2
37	Ginna	New York	9	374	30,260	29,878	29,580	36
38	Indian Point	New York	9	374	30,260	29,878	29,580	37
39	Nine Mile Point	New York	13	139	49,871	59,508	65,466	21
40	Brunswick	North Carolina	11	160	13,649	18,639	28,812	39
41	McGuire	North Carolina	47	322	61,535	117,264	188,937	6
42	Shearon Harris	North Carolina	19	272	24,724	54,745	84,598	16
43	Davis-Besse	Ohio	6	416	22,999	23,501	23,312	45
44	Perry	Ohio	22	141	68,920	75,998	80,167	17
45	Beaver Valley	Pennsylvania	33	279	119,111	115,882	108,656	12
46	Limerick	Pennsylvania	62	350	184,712	222,564	257,462	1

(continued)

Table 2.7 (continued)

Index	Plant name	State	No. of tract	Tract area	Total population (0–10 mile)		2010	Rank
			(10-mile)	(sq. mile)	1990	2000		2010
47	Peach Bottom	Pennsylvania	10	317	35,760	40,396	43,032	30
48	Susquehanna	Pennsylvania	14	287	51,798	53,318	55,117	24
49	Three Mile Island	Pennsylvania	41	297	156,537	177,279	191,325	5
50	Catawba	South Carolina	46	309	101,221	137,392	200,869	4
51	Oconee	South Carolina	8	309	30,342	32,295	33,936	33
52	Robinson	South Carolina	15	281	51,644	58,346	64,579	22
53	Summer	South Carolina	5	457	14,256	18,174	22,287	46
54	Sequoyah	Tennessee	20	312	76,278	90,338	104,716	13
55	Watts Bar	Tennessee	5	417	17,803	22,704	24,916	42
56	Comanche Peak	Texas	6	356	16,383	23,844	28,892	38
57	South Texas	Texas	1	25	3,233	2,848	2,654	61
58	North Anna	Virginia	6	363	14,747	19,529	23,603	44
59	Surry	Virginia	29	356	108,530	121,515	133,856	8
60	Columbia	Washington	1	209	3,530	4,364	6,007	59
61	Point Beach	Wisconsin	5	192	20,905	20,819	19,752	47
	All 61 plants in operation (0–10)		881	17,411	2,872,653	3,320,806	3,785,622	
	All 61 plants in operation (0–50)		21625	286,714	75,560,733	82,930,217	87,470,180	

New York, 15,118,181; (2) Limerick Generating Station, Pennsylvania, 6,559,209; (3) Dresden Nuclear Power Station, Illinois, 4,700,949; (4) Hope Creek Generating Station, New Jersey, 4,372,701; (5) Fermi, Michigan, 4,368,235; (6) Salem Nuclear Generating Station, New Jersey, 4,328,469; (7) Peach Bottom Atomic Power Station, Pennsylvania, 4,124,024; (8) Seabrook Station, New Hampshire, 3,767,215; (9) Turkey Point Nuclear Generating, Florida, 3,318,548; and (10) Pilgrim Plant, Massachusetts, 3,130,058.

The three NPPs with the smallest such populations were as follows: (1) Cooper Nuclear Station, Nebraska, 111,113; (2) Wolf Creek Generating Station, Kansas, 138,464; and (3) Arkansas Nuclear One, Arkansas, 194,963. In 2000, among the ten NPPs with the largest such populations as of 2010, Pilgrim Nuclear Power Station, Massachusetts, replaced Turkey Point Nuclear Generating, Florida (Table 2.8). In 1990, among the ten NPPs with the largest such populations as of 2000, Turkey Point Nuclear Generating, Florida, replaced Pilgrim Nuclear Power Station, Massachusetts (Table 2.8). The three NPPs with the smallest such populations were unchanged relative to 2010 in both 2000 (Table 2.8) and 1990 (Table 2.8).

2.7 Demographic Changes in 1990–2000 and 2000–2010

The percent change in population size within both a 10-mile radius and a 50-mile radius during the periods 1990–2000 and 2000–2010 was tracked. Among communities within a 10-mile radius of an NPP from 2000 to 2010, there was an increase in total population at 44 NPPs, while at the remaining 15 NPPs, the total such population declined. The percent change ranged from a 61% increase, in the area surrounding McGuire Nuclear Station, North Carolina (Fig. 2.6), to a 31% decrease among the communities surrounding Diablo Canyon Nuclear Power Plant, California. Large positive percent changes during the period 2000–2010 also occurred in the areas immediately surrounding Brunswick Steam Electric Plant, North Carolina, 55%, and Shearon Harris Nuclear Power Plant, North Carolina, 55%; a large negative percent change also occurred in the area surrounding Grand Gulf Nuclear Station, Mississippi (−16%). From 1990 to 2000, the largest percent change in total population living within a 10-mile radius of a NPP occurred at Shearon Harris Nuclear Power Plant, North Carolina (121%); the communities surrounding McGuire Nuclear Station, North Carolina, also experienced dramatic population growth (91%).

Fifty-six NPPs saw a positive percent change, or an increase in the population living in communities within a 50-mile radius; the remaining 9 NPPs saw a decrease in such populations from 2000 to 2010 (Fig. 2.7). The percent change range varied between 51 and −7%. The largest percent change occurred among the communities within a 50-mile radius of Palo Verde Nuclear Generation Station, Arizona (51%); the same NPP also saw the largest percent change in the growth of its same such population during the period 1990–2000 (53%). LaSalle County Station, Illinois (28%), and Brunswick Steam Electric Plant, North Carolina (27%), also saw significant growth in the population living within a 50-mile radius of each respective

Table 2.8 Total population living in census tracts within a 50-mile radius of a NPP as of 2010, as measured from census-tract centroid point to NPP

Index	Plant name	State	Tract	Tract area	Total population (50 mile)		2010	Rank
			(50-mile)	(sq. mile)	1990	2000		2010
1	Browns Ferry	Alabama	207	6,353	716,311	812,964	885,374	38
2	Farley	Alabama	94	6,642	316,989	343,659	360,352	55
3	Palo Verde	Arizona	534	6,942	1,295,802	1,799,929	2,207,889	17
4	Arkansas Nuclear	Arkansas	45	6,046	154,290	182,869	194,963	59
5	Diablo Canyon	California	90	3,048	361,432	409,562	448,292	51
6	Millstone	Connecticut	395	5,103	1,522,087	1,589,650	1,667,925	24
7	Saint Lucie	Florida	266	3,296	732,319	930,833	1,151,024	30
8	Turkey Point	Florida	691	4,431	2,489,137	3,024,321	3,318,548	9
9	Hatch	Georgia	72	6,586	243,782	284,616	304,217	56
10	Vogtle	Georgia	139	6,248	517,981	587,317	628,353	46
11	Braidwood	Illinois	660	5,806	2,367,196	2,718,397	3,018,399	11
12	Byron	Illinois	199	5,627	706,621	773,547	821,645	40
13	Clinton	Illinois	154	5,851	548,176	577,409	608,176	47
14	Dresden	Illinois	1037	5,838	3,901,073	4,433,036	4,700,949	3
15	La Salle	Illinois	235	5,775	683,266	886,835	1,137,865	31
16	Quad Cities	Illinois	154	5,824	539,561	547,635	544,388	48
17	Duane Arnold	Iowa	129	5,795	462,956	510,461	543,720	49
18	Wolf Creek	Kansas	39	5,973	133,789	140,997	138,464	60
19	River Bend	Louisiana	161	6,869	656,582	737,814	814,822	41
20	Waterford	Louisiana	487	6,269	1,655,821	1,778,252	1,656,164	25
21	Calvert Cliffs	Maryland	438	6,082	1,460,569	1,605,592	1,719,445	22
22	Pilgrim	Massachusetts	747	4,394	2,907,647	3,078,452	3,130,058	10
23	D.C. Cook	Michigan	227	5,853	809,517	861,818	873,728	39

(continued)

Table 2.8 (continued)

Index	Plant name	State	Tract	Tract area	Total population (50 mile)		2010	Rank
			(50-mile)	(sq. mile)	1990	2000		2010
24	Fermi	Michigan	1312	4,552	4,489,966	4,542,979	4,368,235	5
25	Palisades	Michigan	226	6,785	794,744	882,586	899,600	36
26	Monticello	Minnesota	450	5,299	1,544,634	1,781,553	1,950,169	19
27	Prairie Island	Minnesota	450	5,643	1,465,322	1,686,829	1,800,095	20
28	Grand Gulf	Mississippi	56	6,076	214,616	218,887	210,536	58
29	Callaway	Missouri	81	5,752	307,345	357,726	392,917	53
30	Cooper	Nebraska	38	6,168	117,399	115,868	111,113	61
31	Fort Calhoun	Nebraska	269	5,587	731,120	813,760	890,963	37
32	Seabrook	New Hampshire	868	4,195	3,465,615	3,683,764	3,767,215	8
33	Hope Creek	New Jersey	1097	5,684	4,052,631	4,189,795	4,372,701	4
34	Oyster Creek	New Jersey	583	3,412	2,132,640	2,387,006	2,538,550	13
35	Salem	New Jersey	1088	5,715	4,011,786	4,147,881	4,328,469	6
36	FitzPatrick	New York	212	4,938	757,206	745,522	747,467	43
37	Ginna	New York	264	4,515	987,092	1,020,186	1,035,214	33
38	Indian Point	New York	3760	5,810	13,786,298	14,894,006	15,118,181	1
39	Nine Mile Point	New York	211	4,908	754,261	742,377	744,267	44
40	Brunswick	North Carolina	108	3,040	232,337	316,773	402,395	52
41	McGuire	North Carolina	613	6,366	1,636,412	2,072,499	2,517,850	14
42	Shearon Harris	North Carolina	486	6,217	1,393,352	1,829,822	2,222,038	16
43	Davis-Besse	Ohio	363	4,476	1,343,578	1,354,016	1,349,593	27
44	Perry	Ohio	531	4,905	1,766,037	1,788,572	1,699,459	23
45	Beaver Valley	Pennsylvania	808	5,647	2,824,537	2,757,925	2,655,595	12
46	Limerick	Pennsylvania	1609	5,759	5,986,390	6,282,721	6,559,209	2

(continued)

Table 2.8 (continued)

Index	Plant name	State	Tract	Tract area	Total population (50 mile)		2010	Rank
			(50-mile)	(sq. mile)	1990	2000		2010
47	Peach Bottom	Pennsylvania	1008	5,794	3,569,625	3,845,576	4,124,024	7
48	Susquehanna	Pennsylvania	303	5,863	1,102,337	1,116,488	1,136,292	32
49	Three Mile Island	Pennsylvania	448	5,941	1,718,797	1,906,037	2,068,685	18
50	Catawba	South Carolina	556	6,403	1,437,561	1,819,689	2,235,497	15
51	Oconee	South Carolina	276	6,175	873,312	1,031,201	1,152,820	29
52	Robinson	South Carolina	152	6,363	568,041	616,110	649,720	45
53	Summer	South Carolina	251	6,436	749,396	865,550	971,019	34
54	Sequoyah	Tennessee	205	6,227	747,693	855,343	937,320	35
55	Watts Bar	Tennessee	178	6,455	616,648	731,267	812,206	42
56	Comanche Peak	Texas	268	6,086	881,604	1,050,191	1,220,100	28
57	South Texas	Texas	52	4,663	199,113	215,547	216,206	57
58	North Anna	Virginia	364	6,181	1,085,119	1,322,489	1,553,358	26
59	Surry	Virginia	450	5,599	1,523,998	1,645,196	1,741,096	21
60	Columbia	Washington	71	4,782	234,431	302,914	365,409	54
61	Point Beach	Wisconsin	114	5,150	418,292	461,723	485,589	50
	All 61 plants in operation (0–50)		21625	286,714	75,560,733	82,930,217	87,470,180	
	All 61 plants in operation outside		51432	3,510,028	173,148,625	198,491,689	216,495,092	

Index	Plant name	State	(10-mile)	(sq. mile)	1990-2000	2000-2010	(50-mile)	(sq. mile)	1990-2000	2000-2010
41	McGuire	North Carolina	47	322	90.56%	61.12%	613	6,366	26.65%	21.49%
40	Brunswick	North Carolina	11	160	36.56%	54.58%	108	3,040	36.34%	27.03%
42	Shearon Harris	North Carolina	19	272	121.42%	54.53%	486	6,217	31.33%	21.43%
8	Turkey Point	Florida	26	208	11.39%	48.40%	691	4,431	21.50%	9.73%
3	Palo Verde	Arizona	1	120	54.73%	46.31%	534	6,942	38.90%	22.67%
50	Catawba	South Carolina	46	309	35.73%	46.20%	556	6,403	26.58%	22.85%
60	Columbia	Washington	1	209	23.63%	37.65%	71	4,782	29.21%	20.63%
14	Dresden	Illinois	17	251	22.83%	34.55%	1037	5,838	13.64%	6.04%
26	Monticello	Minnesota	8	308	47.06%	31.96%	450	5,299	15.34%	9.46%
7	Saint Lucie	Florida	35	234	19.07%	31.53%	266	3,296	27.11%	23.66%
53	Summer	South Carolina	5	457	27.48%	22.63%	251	6,436	15.50%	12.19%
56	Comanche Peak	Texas	6	356	45.54%	21.17%	268	6,086	19.12%	16.18%
58	North Anna	Virginia	6	363	32.43%	20.86%	364	6,181	21.88%	17.46%
33	Hope Creek	New Jersey	15	332	15.79%	17.53%	1097	5,684	3.38%	4.37%
35	Salem	New Jersey	15	332	15.79%	17.53%	1088	5,715	3.39%	4.35%
54	Sequoyah	Tennessee	20	312	18.43%	15.92%	205	6,227	14.40%	9.58%
46	Limerick	Pennsylvania	62	350	20.49%	15.68%	1609	5,759	4.95%	4.40%
4	Arkansas Nuclear	Arkansas	8	196	17.78%	14.52%	45	6,046	18.52%	6.61%
34	Oyster Creek	New Jersey	29	287	24.69%	12.77%	583	3,412	11.93%	6.35%
52	Robinson	South Carolina	15	281	12.98%	10.68%	152	6,363	8.46%	5.46%
59	Surry	Virginia	29	356	11.96%	10.16%	450	5,599	7.95%	5.83%
39	Nine Mile Point	New York	13	139	19.32%	10.01%	211	4,908	-1.58%	0.25%
55	Watts Bar	Tennessee	5	417	27.53%	9.74%	178	6,455	18.59%	11.07%
11	Braidwood	Illinois	10	327	16.71%	9.31%	660	5,806	14.84%	11.04%
15	La Salle	Illinois	3	188	3.08%	9.23%	235	5,775	29.79%	28.31%
29	Callaway	Missouri	2	237	32.03%	8.54%	81	5,752	16.39%	9.84%
49	Three Mile Island	Pennsylvania	41	297	13.25%	7.92%	448	5,941	10.89%	8.53%
20	Waterford	Louisiana	18	285	9.50%	7.66%	487	6,269	7.39%	-6.87%
2	Farley	Alabama	5	358	5.15%	7.17%	94	6,642	8.41%	4.86%
47	Peach Bottom	Pennsylvania	10	317	12.96%	6.53%	1008	5,794	7.73%	7.24%
31	Fort Calhoun	Nebraska	5	173	13.60%	6.25%	269	5,587	11.30%	9.49%
17	Duane Arnold	Iowa	22	291	16.84%	6.13%	129	5,795	10.26%	6.52%
44	Perry	Ohio	22	141	10.27%	5.49%	531	4,905	1.28%	-4.98%
10	Vogtle	Georgia	2	325	19.61%	5.10%	139	6,248	13.39%	6.99%
51	Oconee	South Carolina	8	309	6.44%	5.08%	276	6,175	18.08%	11.79%
22	Pilgrim	Massachusetts	15	453	11.69%	5.08%	747	4,394	5.87%	1.68%
36	FitzPatrick	New York	55	292	5.34%	4.88%	212	4,938	-1.54%	0.26%
1	Browns Ferry	Alabama	10	302	6.57%	4.28%	207	6,353	13.49%	8.91%
27	Prairie Island	Minnesota	5	226	7.74%	3.97%	450	5,643	15.12%	6.71%
24	Fermi	Michigan	24	268	5.05%	3.76%	1312	4,552	1.18%	-3.85%
12	Byron	Illinois	5	300	16.04%	3.71%	199	5,627	9.47%	6.22%
48	Susquehanna	Pennsylvania	14	287	2.93%	3.37%	303	5,863	1.28%	1.77%
32	Seabrook	New Hampshire	30	270	15.59%	3.19%	868	4,195	6.29%	2.27%
19	River Bend	Louisiana	5	239	12.52%	2.59%	161	6,869	12.37%	10.44%
6	Millstone	Connecticut	32	266	-3.04%	2.45%	395	5,103	4.44%	4.92%
21	Calvert Cliffs	Maryland	10	258	44.17%	0.16%	438	6,082	9.93%	7.09%
23	D.C. Cook	Michigan	16	183	4.08%	-0.61%	227	5,853	6.46%	1.38%
43	Davis-Besse	Ohio	6	416	2.18%	-0.80%	363	4,476	0.78%	-0.33%
9	Hatch	Georgia	3	333	11.26%	-0.97%	72	6,586	16.75%	6.89%
37	Ginna	New York	9	374	-1.26%	-1.00%	264	4,515	3.35%	1.47%
38	Indian Point	New York	9	374	-1.26%	-1.00%	3760	5,810	8.03%	1.51%
16	Quad Cities	Illinois	7	272	-2.90%	-1.65%	154	5,824	1.50%	-0.59%
13	Clinton	Illinois	4	254	0.22%	-2.12%	154	5,851	5.33%	5.33%
18	Wolf Creek	Kansas	3	654	5.49%	-3.14%	39	5,973	5.39%	-1.80%
25	Palisades	Michigan	8	183	1.35%	-3.36%	226	6,785	11.05%	1.93%
30	Cooper	Nebraska	3	670	-7.88%	-4.26%	38	6,168	-1.30%	-4.10%
61	Point Beach	Wisconsin	5	192	-0.41%	-5.13%	114	5,150	10.38%	5.17%
45	Beaver Valley	Pennsylvania	33	279	-2.71%	-6.24%	808	5,647	-2.36%	-3.71%
57	South Texas	Texas	1	25	-11.91%	-6.81%	52	4,663	8.25%	0.31%
28	Grand Gulf	Mississippi	4	662	4.99%	-15.75%	56	6,076	1.99%	-3.82%
5	Diablo Canyon	California	7	358	3.29%	-31.32%	90	3,048	13.32%	9.46%
	All 61 plants in operation (0-50)		881	17,411	15.60%	14.00%	21625	286,714	9.75%	5.47%
	All 61 plants in operation-outside		21625	286,714	9.75%	5.47%	51432	3,510,028	14.64%	9.07%

Fig. 2.6 Percent change of the total population living in census tracts within a 10-mile radius and 50-mile radius, as measured from census-tract centroid point to the nearest NPP, during the periods 1990–2000 and 2000–2010, sorted according to percent change within a 10-mile radius

Index	Plant name	State	(10-mile)	(sq. mile)	1990-2000	2000-2010	(50-mile)	(sq. mile)	1990-2000	2000-2010
41	McGuire	North Carolina	47	322	90.56%	61.12%	613	6,366	26.65%	21.49%
40	Brunswick	North Carolina	11	160	36.56%	54.58%	108	3,040	36.34%	27.03%
42	Shearon Harris	North Carolina	19	272	121.42%	54.53%	486	6,217	31.33%	21.43%
8	Turkey Point	Florida	26	208	11.39%	48.40%	691	4,431	21.50%	9.73%
3	Palo Verde	Arizona	1	120	54.73%	46.31%	534	6,942	38.90%	22.67%
50	Catawba	South Carolina	46	309	35.73%	46.20%	556	6,403	26.58%	22.85%
60	Columbia	Washington	1	209	23.63%	37.65%	71	4,782	29.21%	20.63%
14	Dresden	Illinois	17	251	22.83%	34.55%	1037	5,838	13.64%	6.04%
26	Monticello	Minnesota	8	308	47.06%	31.96%	450	5,299	15.34%	9.46%
7	Saint Lucie	Florida	35	234	19.07%	31.53%	266	3,296	27.11%	23.66%
53	Summer	South Carolina	5	457	27.48%	22.63%	251	6,436	15.50%	12.19%
56	Comanche Peak	Texas	6	356	45.54%	21.17%	268	6,086	19.12%	16.18%
58	North Anna	Virginia	6	363	32.43%	20.86%	364	6,181	21.88%	17.46%
33	Hope Creek	New Jersey	15	332	15.79%	17.53%	1097	5,684	3.38%	4.37%
35	Salem	New Jersey	15	332	15.79%	17.53%	1088	5,715	3.39%	4.35%
54	Sequoyah	Tennessee	20	312	18.43%	15.92%	205	6,227	14.40%	9.58%
46	Limerick	Pennsylvania	62	350	20.49%	15.68%	1609	5,759	4.95%	4.40%
4	Arkansas Nuclear	Arkansas	8	196	17.78%	14.52%	45	6,046	18.52%	6.61%
34	Oyster Creek	New Jersey	29	287	24.69%	12.77%	583	3,412	11.93%	6.35%
52	Robinson	South Carolina	15	281	12.98%	10.68%	152	6,363	8.46%	5.46%
59	Surry	Virginia	29	356	11.96%	10.16%	450	5,599	7.95%	5.83%
39	Nine Mile Point	New York	13	139	19.32%	10.01%	211	4,908	-1.58%	0.25%
55	Watts Bar	Tennessee	5	417	27.53%	9.74%	178	6,455	18.59%	11.07%
11	Braidwood	Illinois	10	327	16.71%	9.31%	660	5,806	14.84%	11.04%
15	La Salle	Illinois	3	188	3.08%	9.23%	235	5,775	29.79%	28.31%
29	Callaway	Missouri	2	237	32.03%	8.54%	81	5,752	16.39%	9.84%
49	Three Mile Island	Pennsylvania	41	297	13.25%	7.92%	448	5,941	10.89%	8.53%
20	Waterford	Louisiana	18	285	9.50%	7.66%	487	6,269	7.39%	-6.87%
2	Farley	Alabama	5	358	5.15%	7.17%	94	6,642	8.41%	4.86%
47	Peach Bottom	Pennsylvania	10	317	12.96%	6.53%	1008	5,794	7.73%	7.24%
31	Fort Calhoun	Nebraska	5	173	13.60%	6.25%	269	5,587	11.30%	9.49%
17	Duane Arnold	Iowa	22	291	16.84%	6.13%	129	5,795	10.26%	6.52%
44	Perry	Ohio	22	141	10.27%	5.49%	531	4,905	1.28%	-4.98%
10	Vogtle	Georgia	2	325	19.61%	5.10%	139	6,248	13.39%	6.99%
51	Oconee	South Carolina	8	309	6.44%	5.08%	276	6,175	18.08%	11.79%
22	Pilgrim	Massachusetts	15	453	11.69%	5.08%	747	4,394	5.87%	1.68%
36	FitzPatrick	New York	55	292	5.34%	4.88%	212	4,938	-1.54%	0.26%
1	Browns Ferry	Alabama	10	302	6.57%	4.28%	207	6,353	13.49%	8.91%
27	Prairie Island	Minnesota	5	226	7.74%	3.97%	450	5,643	15.12%	6.71%
24	Fermi	Michigan	24	268	5.05%	3.76%	1312	4,552	1.18%	-3.85%
12	Byron	Illinois	5	300	16.04%	3.71%	199	5,627	9.47%	6.22%
48	Susquehanna	Pennsylvania	14	287	2.93%	3.37%	303	5,863	1.28%	1.77%
32	Seabrook	New Hampshire	30	270	15.59%	3.19%	868	4,195	6.29%	2.27%
19	River Bend	Louisiana	5	239	12.52%	2.59%	161	6,869	12.37%	10.44%
6	Millstone	Connecticut	32	266	-3.04%	2.45%	395	5,103	4.44%	4.92%
21	Calvert Cliffs	Maryland	10	258	44.17%	0.16%	438	6,082	9.93%	7.09%
23	D.C. Cook	Michigan	16	183	4.08%	-0.61%	227	5,853	6.46%	1.38%
43	Davis-Besse	Ohio	6	416	2.18%	-0.80%	363	4,476	0.78%	-0.33%
9	Hatch	Georgia	3	333	11.26%	-0.97%	72	6,586	16.75%	6.89%
37	Ginna	New York	9	374	-1.26%	-1.00%	264	4,515	3.35%	1.47%
38	Indian Point	New York	9	374	-1.26%	-1.00%	3760	5,810	8.03%	1.51%
16	Quad Cities	Illinois	7	272	-2.90%	-1.65%	154	5,824	1.50%	-0.59%
13	Clinton	Illinois	4	254	0.22%	-2.12%	154	5,851	5.33%	5.33%
18	Wolf Creek	Kansas	3	654	5.49%	-3.14%	39	5,973	5.39%	-1.80%
25	Palisades	Michigan	8	183	1.35%	-3.36%	226	6,785	11.05%	1.93%
30	Cooper	Nebraska	3	670	-7.88%	-4.26%	38	6,168	-1.30%	-4.10%
61	Point Beach	Wisconsin	5	192	-0.41%	-5.13%	114	5,150	10.38%	5.17%
45	Beaver Valley	Pennsylvania	33	279	-2.71%	-6.24%	808	5,647	-2.36%	-3.71%
57	South Texas	Texas	1	25	-11.91%	-6.81%	52	4,663	8.25%	0.31%
28	Grand Gulf	Mississippi	4	662	4.99%	-15.75%	56	6,076	1.99%	-3.82%
5	Diablo Canyon	California	7	358	3.29%	-31.32%	90	3,048	13.32%	9.46%
	All 61 plants in operation (0-50)		881	17,411	15.60%	14.00%	21625	286,714	9.75%	5.47%
	All 61 plants in operation-outside		21625	286,714	9.75%	5.47%	51432	3,510,028	14.64%	9.07%

Fig. 2.7 Percent change of the total population living in census tracts within a 10-mile radius and 50-mile radius, as measured between the census-tract centroid point and the nearest NPP, during the periods 1990–2000 and 2000–2010, sorted according to percent change within a 50-mile radius

NPP. The largest negative percent change, −7%, occurred among the communities within a 50-mile radius of Waterford Steam Electric Station, Louisiana.

Overall, the total population in areas within a 10-mile radius of one of the 61 US-based commercial NPPs increased 14% during the period 2000–2010 and 15% during the period 1990–2000, while the total population in all other places outside of a 50-mile radius of any NPP saw increases of 38 and 23%, respectively, during the periods 1990–2000 and 2000–2010, respectively (Figs. 2.6, 2.7). The total population of communities sited within a 50-mile radius of any one of the 61 NPPs increased 6 and 10%, respectively, during the periods 2000–2010 and 1999–2000, respectively, while the total population in all other areas of the country increased 9 and 14%, respectively, during the periods 2000–2010 and 1990–2000, respectively (Figs. 2.6, 2.7).

2.8 Conclusion

This chapter provides information on demographic characteristics of population living around the 61 nuclear power plants which are in operations in the USA. There were about 88 million people living in areas within a 50-mile radius surrounding the nuclear power plants in 2010. Among them, 71% were White, 17% Black, 4.4% Asian, 6.9% listed as Other, 13.18% Hispanic, and 36.32% People of Color. Within a 10-mile radius area, the ten NPPs with the largest population range from 258,462 (Limerick Generating Station, Pennsylvania) to 120,876 (Seabrook Station, New Hampshire). The three smallest communities range from 2,654 (South Texas Project, Texas) to 6,007 (Columbia Generating Station, Washington). Within 50-mile radius areas, the ten NPPs with the largest population range from 15,118,181 (Indian Point Nuclear Generating, New York) to 3,130,058 (Pilgrim Plant, Massachusetts). The three smallest communities range from 111,113 (Cooper Nuclear Station, Nebraska) to 194,963 (Arkansas Nuclear One, Arkansas). From a nuclear emergency management point of view, these data could be interpreted as challenges to effectively carry out various activities in response to any of the potential nuclear emergencies associated with the NPPs. For example, if an emergency occurs at Limerick Generating Station in the Pennsylvania plant, the challenge is to evacuate a population of 258,462. Protecting a quarter of a million people living within a 10-mile radius poses tremendous challenges for federal, state, and local governments. In the previous three historic nuclear power accidents (discussed in Chap. 1 under the topic 3.1), evacuation orders actually took place many hours after the core-meltdown accident occured. Therefore, a quarter million people could face potential risks of exposure to the nuclear radiation materials before they have been officially evacuated if an accident takes place at the Limerick Generating Station. When looking at the larger area evacuation of within 50-mile radius, the impacted population size could be as big as 15 million if the nuclear accident takes place at the Indian Point Nuclear Generating, New York. Evacuation comes with a price, as evident by the evacuation-related deaths in the Fukushima nuclear power accident discussion in Chap. 1. The location could be more complex, and the deaths related with evacuation could be high in areas such as New York because of the high-rise buildings in close proximity and in a condensed area. According to the Fukushima accident, the evacuation-related deaths were about 10% (about 1,600 deaths out of 16,000 evacuees, Chap. 1, topic 3.1). If this death rate applies to the potential accident in New York, it could be 1.5 million deaths. In addition, the most vulnerable groups when addressing evacuation planning and risks of exposure are women, seniors, and children who live in areas surrounding the NPPs. As depicted in Table 2.1, 45 million women, 8 million seniors who are 65 or older, and 1.5 million children who are younger than 5 years live within 50-mile radius areas. This includes exposure to day-to-day low radiation risks as well as potential exposure to high-level radiation during a nuclear emergency. Low-level radiation from day-to-day operation could cause leukemia and cancer to child (Yoshimoto et al. 2004). Similarly, elderly populations, within the age range of 50–74 years, were noted to be linked to higher likelihoods of leukemia and cancer mortality rates (Yoshimoto et al. 2004).

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