

INFLUENCE OF ARCHITECTURAL SOLUTIONS ON BUILDING HEAT PROTECTION WITH EXAMPLE OF HISTORICAL RURAL HOUSES IN NORTHERN CASSUBIA

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Abstract

This paper is dedicated to the shaping of traditional historical rural houses in the context of building heat protection. Special attention was paid to certain architectural elements of the building, such as its shape, layout of the rooms and functional connections between them, application of material and constructive solutions, and the location of the house on the plot, including the plan of its surroundings. The research concerning the existing historical buildings was carried out in randomly selected villages in coastal, northern Cassubia. This area is characterized by certain definite common features. The basic selective criteria of the researched area were its specific climate conditions, uniquely affecting the shaping of functional and spatial elements of the traditional rural houses. The recapitulating table presents the characteristic architectural elements affecting the building heat protection in the rural houses from the 19th century. It has been stated that folk architecture, as a result of the work of numerous generations, and thus characterized by skilled adaptation to the natural environment and climate conditions, should be currently the pattern and inspiration for quests of low-energy-consuming solutions during the design of rural dwelling houses.

Streszczenie

Artykuł poświęcony jest kształtowaniu tradycyjnych historycznych domów wiejskich w kontekście ochrony cieplnej budynku. Zwrócono szczególną uwagę na elementy architektury budynku, takie jak: jego kształt, w tym forma przestrzenna dachu, układ pomieszczeń i powiązań funkcjonalnych, zastosowanie rozwiązań materiałowo-konstrukcyjnych oraz usytuowanie domu na działce wraz z rozplanowaniem jego otoczenia. Badania dotyczące istniejących historycznych budynków, przeprowadzono w wybranych w sposób swobodny wsiach na terenie północnych Kaszub nadmorskich. Obszar ten charakteryzują określone wspólne cechy. Podstawowym kryterium wyboru terenu badań były jego specyficzne uwarunkowania klimatyczne, wpływające w szczególny sposób na kształtowanie elementów funkcjonalno-przestrzennych tradycyjnych domów wiejskich. Sporządzono zestawienie charakterystycznych wybranych elementów architektury wpływających na ochronę ciepłą budynku w domach wiejskich z XIX wieku. Stwierdzono, że architektura ludowa, będąca wynikiem pracy licznych pokoleń i charakteryzująca się umiejętnym dostosowaniem do środowiska naturalnego i warunków klimatycznych, powinna stać się wzorem i inspiracją do poszukiwań rozwiązań niskoenergochłonnych obecnie przy projektowaniu budynków mieszkalnych na wsi.

Keywords: Rural detached house; Building heat protection; Building architectural elements.

1. INTRODUCTION

Nowadays, building heat protection depends on assumed technical requirements concerning heat and moisture as well as on the building materials used, namely on their properties affecting energy savings and environmental protection. The fulfillment of the actual requirements on building heat protection can be achieved on the design stage thanks to the application of complex techniques and methods (technical solutions limiting energy consumption) as well as on the construction stage by using modern thermoinsulating materials and execution technology, with increased financial outlays. Building heat protection translates into energy efficacy of buildings which can be evaluated by their users based on building heating costs. According to Laskowski, building heat protection is the sum of the practical application of heat physics based on algorithms and resulting in empirical quantification, on the knowledge of the properties of building materials and – in many cases – on economical reasons [1].

For human beings, optimal thermal conditions were always one of the most important factors deciding the choice of settlement. With the passage of time, this place obtained the name of something commonly understood as a house, i.e. a space which can be arranged to satisfy the most important life needs which also dictates a positive physical and mental state [2]. Among them, one can name the need for safety, including adaptation of the house to climate conditions (unfavorable weather influence). Thanks to certain defined techniques and technologies developed through the ages, houses were adapted in natural ways to be functional in accordance with the natural environment. Rational architectural and urbanistic solutions came into being mainly under the influence of climate, and houses were erected with the use of local building materials and their thermal properties [3]. Many manners of building erection, mainly in the Mediterranean region and in desert climates, used thermal mass of thick earth walls in aim to store cold and heat. An ancient object – Greek and Roman – based on “sun capturing” [4]. Studies on Greek and Roman architecture show the correctness of form and construction enabling proper insulation as well as natural ventilation of buildings [5]. A simple form of the object passively using solar energy became the basis for further quests of proper spatial solutions and for further elaboration of the scheme of the so-called “solar envelope” which is characteristic for each latitude [6]. It was Socrates who was the most contemporary acknowledged author of the solar

house. His concept of the house ensured maximum use of the sun in winter (the sun heated the main room – *oikos*) and total protection of the building’s dwelling part against direct sun in summer. Perpendicular city plans, with a net of streets running north-south and east-west, enabled maximum exposition of every house to the sun [7]. This has been proven in archaeological excavations in Olynthus, Priene, Delos and Colophon.

An important feature of building design in cold climates is the use of air stratification in a room – the phenomenon consisting in raising warm air and lowering cool air [8]. This has been applied, for example, in igloos which give shelter to their occupants in the coldest climates. They spend the majority of time on the upper level where the warm air gathers, whereas in the lower part of the house – where the cold air falls – the house entrance is situated [9].

Some solutions, developed through the years in Middle Europe, were characterized by building heat protection. An example can be a rule of working heat distribution in a traditional Latvian house. The heat coming from the bonfire or solar energy was absorbed mainly by the accumulation mass of the centrally situated room with the kitchen and chimney. The absorbed heat was gradually emitted to other rooms in the building, heating them. An important factor was material which stored the heat – more precisely, it was the material’s density which enabled it to maintain temperature for longer periods of time [10]. The capacity of the accumulation mass (thermal inertia) of the building depended at that time on many factors – apart from the heat capacity of the applied material, also important was the location of the heat source, so-called hot core, its relation to other parts of the building, and ventilation solutions applied.

Nowadays, the binding priorities and directives for building design are the result of an ongoing quest for effective solutions, i.a. in architecture. This quest bears fruits in diversity of various functional and spatial systems which, in turn, result mainly from the adaptation of the house to local conditions. The contemporary building construction, characterized by the rational use of energy, draws inspirations i.a. from a rural hut – the basic pattern of traditional Polish folk architecture. It is worth then to use the experiences and wisdom of previous generations. The inhabitants of houses erected in the country, especially in the 2nd half of the 20th century, know how much a mindless breaking-off with tradition costs. The houses are difficult to heat due not only to

improper materials, but also uneconomical functional and spatial solutions.

2. RESEARCH METHODOLOGY

Taking into consideration the problems undertaken in the paper, two types of research were used: indirect and direct.

In the indirect research, the monographic method was used; it was based on critical analysis of literature along with propositions of the researchers' own conclusions. Simultaneously, certain methodological assumptions were assumed a priority – their intention was to clear the research area and restrict its object range. As historical rural houses were defined, those which had been erected in Poland in the 16th century, became popular particularly in the 19th century, and still exist and preserve regional features.

In the direct research, however, two methods were applied:

- a diagnostic survey via a free interview technique directed to informants (rural house proprietors, representatives of local communities) in coastal Cassubia, the region which had been chosen by the first co-author,
- an empirical method consisting in the analysis of the selected architectural elements affecting the thermal protection of the existing houses (shape of the buildings, including the spatial form of the roofs, layout of rooms and functional connections, materials and constructive solutions applied, location of the building on the plot along with a layout of its surroundings) and using personal observations.

The predominating trends in all of Poland were confronted with investigations in coastal Cassubia. The descriptions of specific architectural solutions, connected to the appropriate illustrative material (photos and drawings made by the first co-author), were assumed necessary to depict the problems being discussed in the paper.

2.1. Research material

The investigations concerning the existing historical rural building development were carried out in randomly selected villages in northern coastal Cassubia. This region is characterized by certain defined common features (Fig. 1a). The basic criterion of the selection of the area for investigations was the specific climate conditions affecting the shaping of archi-

tectural elements of the traditional rural houses in unique ways.

The southern and middle part of Cassubia has been described in literature, cf. [11, 12]. In the investigations on the Cassubian material culture, the publication by J. Knyba [13] is the first monograph which comprehensively presents the characteristic features and development processes of the folk architecture of this region from the end of the 17th until the beginning of the 20th century. There is only few studies, however, containing information about the rural architecture of coastal Cassubia and they present too little material to show both the features and the development process of the tradition of this region. According to the authors, the most important source of knowledge about this topic are the standing objects of the rural traditional architecture, preserved until today, and the information, obtained from the oldest inhabitants of the villages, concerning those objects of the folk architecture of this region which do not exist anymore. There are over ten preserved traditional objects from the 19th century in northern coastal Cassubia. Among them, noteworthy are historical rural houses in the open-air ethnographic museum (“skansen”) in Nadole, on the Zarnowiec Lake, as well as in Kluki, on the Łeba Lake.

During the investigations concerning the architecture of the existing houses in the context of the buildings' thermal protection, the authors have been inspired by the traditional rural architecture represented by several objects – presented in the paper – from the 19th century: modest, austere, having great architectural and artistic simplicity.

The main feature of the selected regions of coastal Cassubia is their climate – having a transitional character between the marine climate typical for Western Europe and the continental one typical for Eastern Europe [14]. According to the accepted classification, the area investigated by the authors belongs to the eastern-coastal region (RIII), covering the eastern part of the Slovincian Coast (Polish “Pobrzeże Słowińskie”, German “Slowinzische Küste”) and a part of the Cassubian Coast. The specificity of the climate conditions of this area consists i.a. of a relatively high number of cool days with precipitation. On average, there are almost 53 cool days, almost 30 cool and clouded days, and 32 cool days with precipitation. Moreover, this area is characterized by the highest annual wind speed in Poland ($5\text{-}6\text{ m/s}^{-1}$ on the height of 30 m.o.g.l.), what means that it is rated among the most profitable regions for the develop-

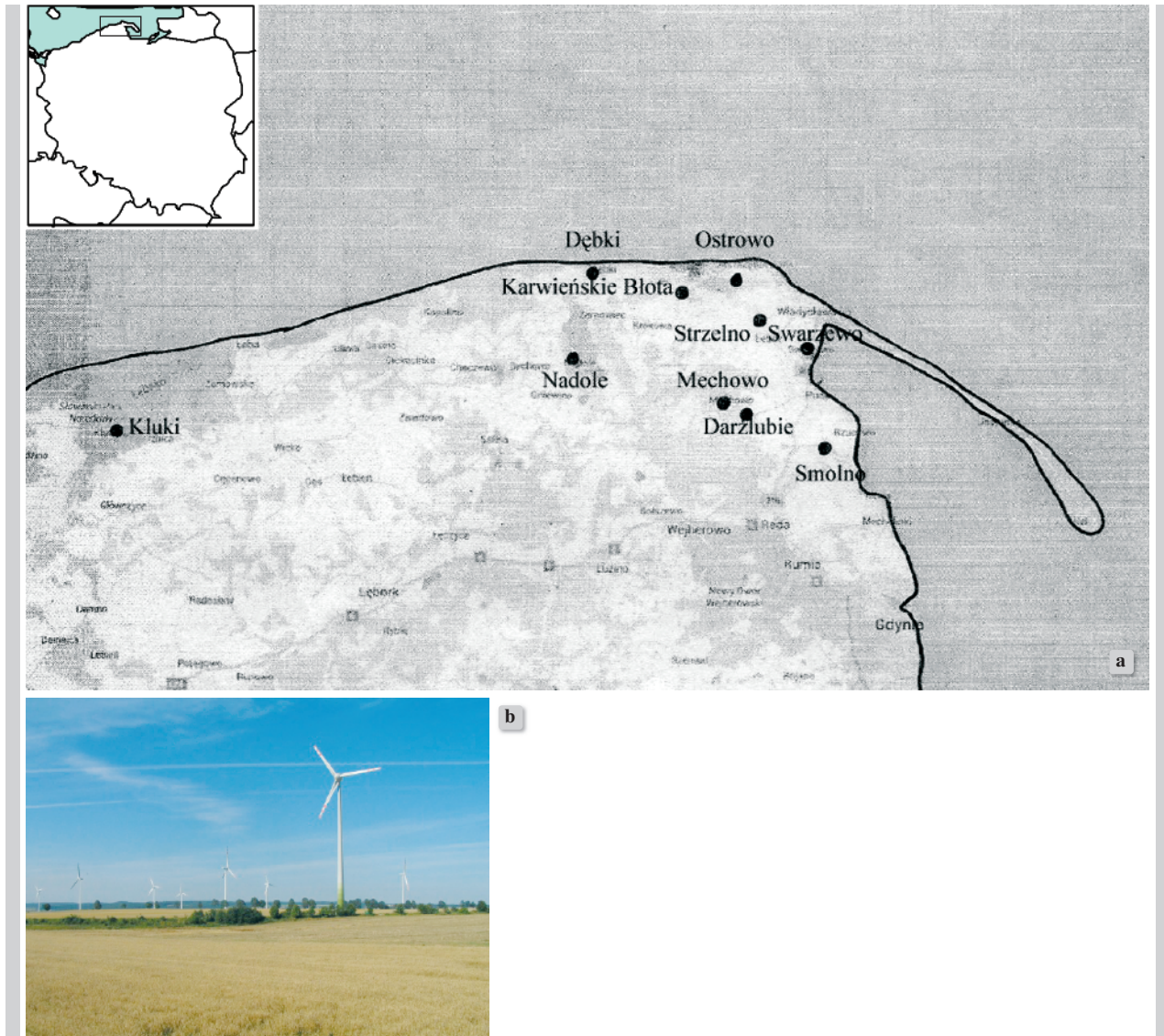


Figure 1.

Direct research area: a – selected rural regions in coastal Cassubia with the places marked where direct research which consisted of evaluating the existing buildings was carried out, b – the characteristic landscape with wind power plants in the surroundings of Gnieźdżewo in Cassubia (photo by M. Górecka)

ment of wind power engineering in Poland. South-west and north-west winds are predominating. It is connected with the general atmospheric circulation of the zone of moderate latitudes winds blow in all directions in this zone but with the distinct advantage of the western direction. They are rather heavy, particularly in autumn and winter. The specific conditions of coastal Cassubia enable the use of this unconventional energy source in this region through construction of wind power plants which decidedly affect the landscape shaping (Fig. 1b).

3. RESULTS OF THE INVESTIGATIONS

3.1. Shape of buildings

The houses stood out because of their dense mass, usually on a rectangular plan, which fundamentally affects more advantageous thermal conditions.

In folk architecture, a high roof was the main factor affecting the thermal protection of a building as well as its mass and the architectural expression of the house connected to this mass – and, above all, it was the roof's area, shape, and appropriately selected proportions in comparison to the house walls. The



Figure 2.
Characteristic forms of rural dwelling houses in coastal Cassubia: a – Ostrowo, b – Swarzewo, c – Dębki, d – Nadole, e – Kluki, f – Smolno, g – Karwieńskie Błota (photos by M. Górecka)

form of the roof was shaped, first of all, according to climate conditions, mainly wind influences and precipitation affecting the construction of the cover, the shape of its spatial form, the slope angle of the roof, the way of covering, and the area of eaves. The roof slope angle, favoring the fast flow of water and the slipping down of snow for a given covering material, as well as the protruding of the eaves' edge out of the wall, were almost directly proportional to the precipitation sum in a given region. The largest eaves were found in the northern Poland as well as in Beskids and Podhale [15].

The protruding eaves were this element of the roof which was characteristic for rural houses played the role of arcades and, most importantly, protected the walls against moisture from precipitation. They also often played a role of an entrance protection. Simultaneously they shaped a microclimate around the house and, on sunny days, they threw a deep horizontal shadow which protected the rooms against overheating in summer.

An attic inside the high roof of the rural house was a good insulator of the ground floor and generally was not used for dwelling; only sometimes it served as storage for foodstuffs or crops. A gable roof or half-hip roof predominated in northern Poland, a hip roof or gable roof with smaller cubature of space under the roof ridge – in southern Poland and in some central regions. Hip roofs have survived for the longest time in Lesser Poland, Podlasie, and in some regions of Mazovia, gable roofs were characteristic mainly in Podhale and the Beskids [16, 17].

Another characteristic elements in rural architecture, having essential influence on the thermal protection of the house, were canopies and porches. They played an important role of sheltering the house entrance against precipitation and wind, and, in summer, also against the sun.

The hut of northern (coastal) Cassubia is represented by several variants, differing from each other. However, it is always a house with wide frontage, usually without a canopy [13]. Only in tightly built-up set-

lements, the gable side has a canopy in the form of a recess which shelters an entrance. It is sometimes found in hamlet-type settlements where the buildings unite both a dwelling and farming part under one roof. Other common features of the dwelling houses in northern Cassubia are: high half-hip roof (rarely gable roof) with rafter-type construction, usually with a squint window under a ridge, framed in wind braces and finished with a decorative finial on the top (called “śparogi” – only plural), loosely covered with reed (rarely straw), and, in extremely poor regions, with heather.

The examples of Northern Cassubian huts are the preserved buildings from the 19th century in Ostrów, Swarzewo, Dębki, Nadole, Kluki, Smolno, and Karwieńskie Błota – the reconstruction (Fig. 2).

The Cassubian hut in Karwieńskie Błota is an example of a building of hamlet-type settlements where the connection of dwelling and farming parts under the common roof was a characteristic feature. It contributed to a significant improvement of the energy balance of the object thanks to a reduction of the area of external walls. A similar solution of the connection of dwelling and farming parts characteristic of the huts in Swarzewo, where one object with a gable roof rarely found in this region was preserved. Such covering can be found also in traditional fishermen’s huts, and the historic house in Dębki can be an example of this.

The preserved dwelling houses in Kluki, Nadole, Ostrów, and Smolno are typical for the architectural landscape of northern Cassubia of the 19th century. In Smolno, a tightly built-up settlement, apart from the huts without canopies characteristic for this region, the houses were erected also with a canopy in the form of a recess protecting the entrance zone against the negative influence of atmospheric conditions. Special attention should be drawn to a dwelling house localized in a historical homestead in Nadole, representing a type of traditional rural complex preserved in the vicinity of Żarnowiec Lake. The hut is singled out by the architectural elements typical for this region and affecting the building’s thermal protection: the tight mass on a rectangular plan, advantageous for thermal protection, as well as the high rafter roof of half-hip type, covered with reed, with the squint window under the ridge. The covering has an appropriate roof slope angle, equal ca. 48°, and eaves protruding out of the external walls at 80 cm. This solution constitutes the protection of the external walls – including the gable walls, additionally sheltered with the gable – as well as the entrance

zone against negative atmospheric conditions. The attic of the dwelling house – as the place of grain storage – was a good insulator of the ground floor. Quite small usable height of the rooms in this building, equal ca. 2.2 m, contributed to the thermal protection of the building.

3.2. Room layout and system of functional connections

The heat protection in folk architecture manifested in the room layout in buildings as well. The rooms had quite low height – equal ca. 2.2 m [18]. Depending on the regions in Poland, different layouts of dwelling houses developed – affected not only by functional reasons or local traditions but also by climate conditions. It is noteworthy that the one-bay layouts were found mainly in the southern, south-eastern, and partly central regions of Poland. The transitional systems, one-and-half-bay layouts, consisted of rooms of different heights, were characteristic of houses mainly in the mountain and sub-mountain regions, whereas the two-bay layouts were more popular in the northern and north-eastern regions, where mean daily temperatures are lower and winters last longer [19]. This is justified by the fact that the two-bay layout is more advantageous on account of the limitation of heat loss from the building. Simultaneously in the prevailing part of northern Poland predominated houses on a tight plan with square-shaped outline. In the southern regions, however, houses were characterized by an elongated plan. The number of bays, such as the house’s width and length, had crucial influence on the type of roof and its proportion related to the house’s walls. The room layout was adapted to various climate conditions and work organization in summer and winter, which manifested in the changing functions of the dwelling chambers, mainly the kitchen and entrance hall [20]. The latter, however, at first played a role of shelter against climate factors. Especially noteworthy is the division of the building onto warm and cool zones.

The location of the chimney in the hut was tightly connected to the building’s interior layout. However, in the significant majority of cases, only one chimney is observed, which means that the kitchen and heating elements are concentrated in the central part of the building. This solution enabled the heating of rooms localized near the home’s bonfire. The most noteworthy is special care that both builders and dwellers took of the chimney system which provided the economical management of energy. One of the

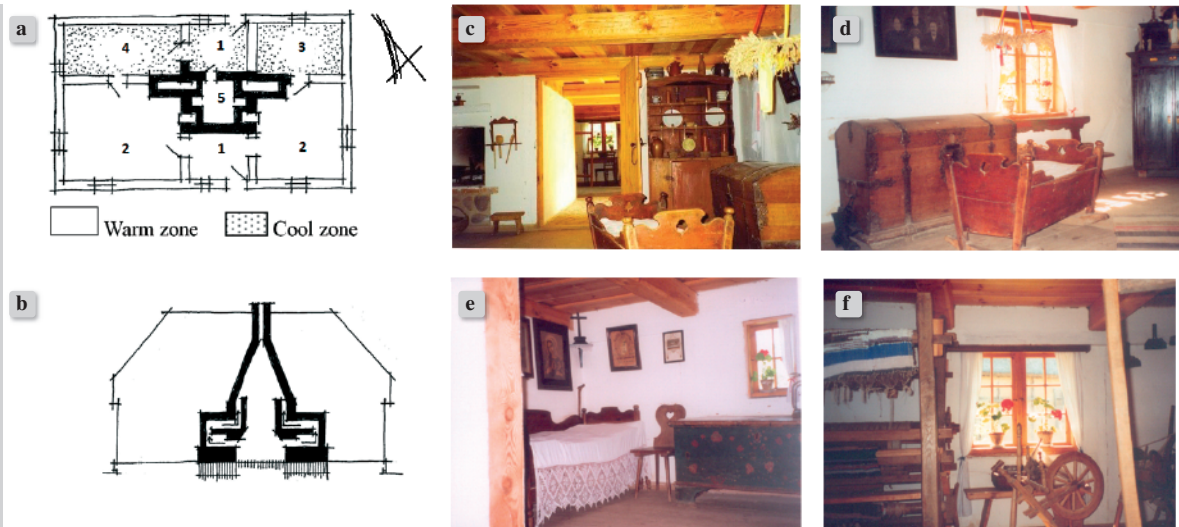


Figure 3.

Room layout in the hut in Nadole: a – general plan of the basement (1 – entrance hall, 2 – main chamber, 3 – corner annex, 4 – larder, 5 – black kitchen), b – section through the chimney facilities, c – view of the entrance hall from the main chamber belonging to the building’s warm zone, d – the main chamber in the building’s warm zone, view of the “holy corner”, e – the room occupied by grandparents in the building’s warm zone, f – corner annex with a small window in the building’s cool zone (photos and drawings by M. Górecka)

advantages of the traditional ovens was that they accumulated heat and removed excess moisture from the rooms, mainly from over the kitchen stove, thanks to an uptake hole. In the buildings of southern and central Poland, for example in Mazovian huts, the chimney chambers were mostly a bit narrower than those in southern Poland [17].

The hut in Nadole, like other dwelling houses presented in the paper, represents the two-bay layout, characteristic for Cassubia, dividing the interior into a cool and warm zone (Fig. 3a). The south-western, warm zone was occupied by grandparents, young hosts with children, and a housemaid. The main entrance to the building led from the direction of a flower garden, through a hall paved with fieldstones, to the main big chamber where family life concentrated (Figs. 3c, d). The hall protected the building’s interior against wind and inflow of freezing air. Beyond the main chamber, in the cool zone of the building, a larder was localized, full of objects connected to the processing and storing of food. The opposite, smaller part of the hut was occupied by grandparents (Fig. 3e). A corner annex with a small window in the building’s cool zone served as a bedroom and, mainly, as a cubbyhole for more precious clothes and belongings (Fig. 3f). It is noteworthy that the building’s cool zone is made up of farming rooms according to the zone rule; the rooms with lower heat requirements are situated on the northern side of building.

The specific role in the building was played – as mentioned – by the fire system. A “black kitchen” – a chimney shaft, wide at its base was entered from the hall. The shaft functionally connected the inlet to heating stoves, fed with lumber and peat, with the smoke and soot offtakes from niche fireplaces in the rooms (Fig. 3b). Apart from the “black kitchen”, found in northern Cassubia and popular among the German population, also a “white kitchen” was found in middle and southern Cassubia, an “evolutionary” variation of the “black kitchen” as well as niche kitchen hearths.

3.3. Structural elements of buildings

Folk architecture used building materials which were accessible in a given region, with help of simple devices. Thus it was organic, and its form, developed through generations, can inspire modern architects. Low temperature and its daily variations affected the selection of traditional materials for the construction of external baffles, allowing the natural diffusion of air and the regulation of humidity. Traditionally, the basic building material in Poland was wood, and its application had direct connection to the afforestation level in the separate regions of the country. Wood is characterized by many advantages but the most important of them is that it has good properties concerning heat protection and buildings made of it ensure the optimum health conditions to their



Figure 4.

Selected material and constructive solutions: a – a timber-framed wall filled with clay on perches in the Cassubian hut in Nadole, b – a detail of the timber-framed wall filled with ceramic brick in a farming building in Darżlubie, c – a detail of a reed-covered, half-hip, rafter-type roof with squint window under a ridge and with decorative finial (“pazdur”, “šparogi”) – the hut in Nadole, d – a detail of a small window (nowadays coupled), with wooden shutters, in Karwieńskie Błota (photos by M. Górecka)

dwellers. A log system predominated in the constructive solutions of solid wooden walls; the joints between separate beams were sealed with moss, couch grass or heather, then covered with decorative straw plaits or usually filled with clay and straw and limewashed. Wall thickness depended on climate regions. A certain conformity is observed between the regions with low winter temperature and the regions where the walls of rural houses had bigger areas of section compared to other regions [21]. Construction of solid wooden walls of the log system predominated in the central and southern parts of Poland. Lesser Poland and Podlasie are the regions where it has survived for the longest time in the pure form. Timber framing, characterized by the ability of heat accumulation and wood saving, prevailed in the northern and western regions of Poland, mainly in Źuławy and Greater Poland [16, 17]. When one talks about traditional folk architecture, they usually think about buildings made of wood and forget those made of clay, brick, or stone. The significance of these materials, however, increased tremendously during the reconstruction of the country after the introduction of property rights reforms, especially in northern and western Poland.

The roof cover in traditional folk architecture was mainly straw and reed. The predominating cover in the middle and southern regions, i.e. those where farming was intensive, was straw thatch; light and

having good thermal and insulating properties consisting in keeping up the optimal temperature in all rooms, both in winter and summer. Straw cover, more resistant to humidity and drought as well as better resistant to water, was used mainly in the northern regions of Poland, in Pomerania and the Lake District [16].

The care of the building heat protection manifested also in the fact that the window and door openings – through which the significant quantity of heat escaped were limited to a minimum. Therefore, rooms not always were lit well. The windows usually had single panes which reduced their thermal and insulating properties. Simultaneously they were drafty, mainly due to improper fitting and not very thorough workmanship. However, decorative wooden shutters are noteworthy they were often used, usually closed for the night and in some regions, even for the whole winter. In this latter case, they were sealed with straw and opened only for spring. It must be emphasized that the shutters were a newer building element in the huts, although custom of the covering of windows is old. Long ago windows used to be insulated from the outside with straw mats attached with wooden pegs to the wall above the window opening. Window and door bands also protected against excessive heat loss; their role consisted mainly in sealing off the connection between the door or window frame and the wall [22]. Cassubian huts were usually

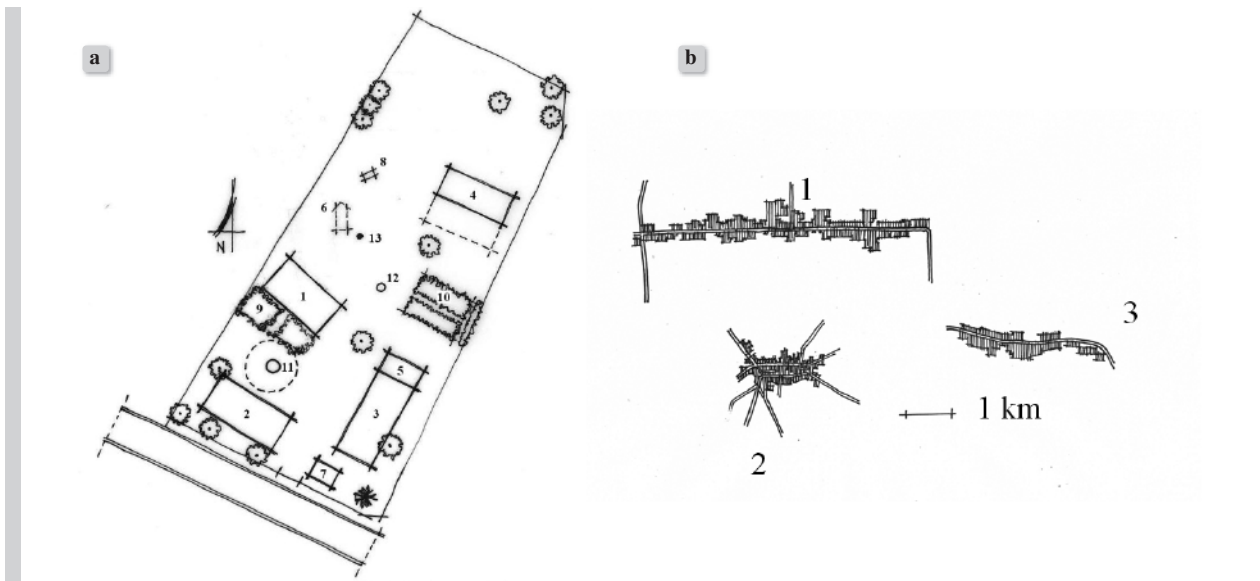


Figure 5.

Localization of buildings: a – plan of a wealthy farmer's farmstead in the "skansen" in Nadole (1 – dwelling house, 2 – barn, 3 – cowshed, 4 – another dwelling house, built later, 5 – coach house, 6 – cellar, 7 – building of the museum administration, 8 – bread oven, 9 – flower garden, 10 – vegetable garden, 11 – horse gear, 12 – well, 13 – pigeon loft), b – today's Cassubian villages with street systems, developed in history, enabling to maximally expose the dwelling houses to the sun (1 – Karwieńskie Błota, 2 – Strzelno, 3 – Mechowo) (drawings by M. Górecka)

built in timber framing, which was treated as a transitional form between wooden and brick construction which constituted a medley of foreign influences and native forms of architectural art. The walls, erected as a frame with free spaces filled with unfired clay, called "paca" (pronounced [pa-tsa]), imitated the timber framing filled with fired clay. The application of "paca" was connected to the lack of local brickyard centers, increasing the price of bricks. Timber framing ensured that heat was kept inside in winters and mildly cool air in hot summers. The massive filling of the wooden skeleton with clay was characterized by high heat accumulation and relatively advantageous thermal properties. Despite the appearance of trapping humidity inside, this construction in fact had a dry interior (Fig. 4a). Some timber-framed walls filled with brick were covered with pugging made of gravel and clay to improve thermal conditions inside as well as to protect the wooden elements of the construction (Fig. 4b).



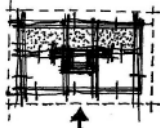


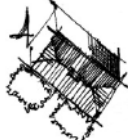
The most popular material for covering of roofs in this region, apart from straw, was reed (Fig. 4c). A roof covered with straw and reed survived for many years in Cassubian architecture despite bans and orders of the Prussian and then German and Polish authorities.

The windows in buildings were small, with single panes. The layout of windows in separate rooms is

connected to the illumination of the hut's inside. Apart from that, it is noteworthy that the window size was adapted to a zone depending on the temperature inside. The largest windows were situated in the building's warm zone – in the living rooms, smaller – in the corner annex, the smallest – in the chamber and entrance hall belonging to the building's cold zone. The four-pane frame in a small window was usually $0.65 \div 1$ m wide and $0.6 \div 1$ m high. The windows in the corner annexes usually had only two panes, arranged vertically. At the end of the 18th and the beginning of the 19th century, Cassubian huts had also some smaller openings which played a role of window vents in summer and were clogged with straw and moss in winter. Up until the beginning of the 19th century windows played a role of light source in the wealthy farmers' houses and until the end of the 19th century in poor people's houses, but they did not regulate the fresh air flow throughout the hut's inside. As movable window casements had been introduced thanks to hinges, a need arose to mount windows in walls in a more durable way, using jambs, which also contributed to the reduction of heat losses from buildings. Shutters were an integral part of windows in Cassubian huts from the 19th century on. Their task, apart from protection against thieves, was protection against excessive chilling of the hut's inside. Shutters were placed on the windows having the larg-

Table 1.

Characteristic selected architectural elements affecting the building's thermal protection – folk architecture from the 19th century, coastal Cassubia (drawings by M. Górecka)

Selected elements of architecture	Characteristics of the selected elements
	<ul style="list-style-type: none"> • dense building mass on a rectangular plan, • high roof, playing the role of a thermal buffer for the ground floor; it has an appropriate slope angle – ca. 48° – and eaves protruding out of the external walls at 80 cm (protection of external walls including the gable walls and building entrance zone), • canopy in a form of a recess, placed in the gable wall and protecting the entrance (in tightly built-up settlements, e.g. in Smolno)
	<ul style="list-style-type: none"> • small usable height of rooms – ca. 2.2 m.
	<ul style="list-style-type: none"> • two-bay layout dividing the interior into a cool zone (farming rooms) and warm zone (representative rooms), • entrance hall protecting the building's interior against wind and inflow of cold air; the entrance zone is protected against atmospheric conditions by an external architectural element – eaves, • presence of only one chimney – concentration of heating and kitchen facilities, constituting a massive reservoir of heat energy, in the central part of a building
	<ul style="list-style-type: none"> • application of local building materials with good thermoinsulating properties (wood, clay on perches as well as reed, characterized by relatively high ability of heat accumulation), • the timber-framed walls filled with brick are covered by pugging made of gravel and clay
	<ul style="list-style-type: none"> • few window openings with small areas depending on the zone connected to interior temperature (the ratio of window area to floor area is equal ca. 1:13), • wooden shutters by larger windows
	<ul style="list-style-type: none"> • joining of dwelling and farming parts – improvement of the energy balance (hamlet-type settlements, e.g. in Karwieńskie Błota and Swarzewo), • orientation of a dwelling house towards the sun (for the house in Nadole, the declination from the N-S direction is equal ca. 35° towards the west)

er area, whereas they were not applied to cover small, single-casement windows (Fig. 4d).

3.4. Localization of buildings and concepts of their surroundings

Climate conditions affected also the localization of rural buildings which were situated mainly in sun-exposed windy areas. In Polish folk architecture, the mountainous regions excluded, across time people avoided to erect houses in valleys and terrain depressions. The traditional huts' fronts were often south-oriented which i.a. protected the chamber against overheating. Simultaneously, trees were planted on windward side.

The Cassubian huts in Karwieńskie Błota and Swarzewo are additionally examples of a building of

hamlet-type settlements where the unification of dwelling and farming parts under the same roof was a characteristic feature. It contributed to significant improvement of the energy balance of the object thanks to a reduction of the area of external walls. The whole farmstead constituted a functionally justified structure, present for generations. It represented a centripetal system which has always been the most numerous and oldest group of functional and spatial types of settlements adapted to technologies based on physical work.

The majority of Cassubian villages were built-up in such a way that dwelling houses were sun-oriented, and that definitely affected the heat management in the building. Simultaneously, the localization of a flower garden did not overshadow the southern elevation of the house (Fig. 5a). The examples of

Cassubian huts in the investigated region are Karwieńskie Błota, Mechowo, Strzelno (Fig. 5b); the roads there run in the east-west direction enabling to maximally expose the dwelling houses to the sun.

The completed literature review and the authors' own research illustrates the difference between the characteristic architectural elements of the historical rural houses from the 19th century in coastal Cassubia from the point of view of the thermal protection of buildings (Table 1).

3.5. Traditional solutions in contemporary houses

The importance of planning low energy consumption and healthy rural houses while considering local climate conditions and basing construction on traditional methods, with simultaneous application of technological innovations being in favor of the building heat protection, acquires increasing significance. Each house should be built in relation to the environment and use the full potential of its surroundings.

It is noteworthy that part of the rules developed in folk architecture in the past connected to the thermal protection of buildings can become a part of the architectural trends concerning modern low-energy consumption buildings. These solutions, complying with the climate of a region, were developed by our ancestors mainly by means of empirical methods of solving of problems based on rational premises. Several solutions in this field can be treated as fundamental: a compact building mass, usually on a rectangular plan; a simple gable or hip roof with buffer spaces and wide eaves; the interior's division into warm and cool zones; the exposure of the maximum part of a building to the sun; the protection of a building against the wind.

Simultaneously, still-increasing demands on energy savings force the application of external baffles with a low overall heat transfer coefficient which is binding nowadays in common building construction. The basic difference, apart from the technological progress, consists i.a. in materials and constructive solutions of external baffles. Methods of their erection in historical buildings depended on the availability of a building material in the given region but in the majority of cases (i.a. in the investigated region of coastal, northern Cassubia) they were independent of the exposure to the sun. The southern walls in the currently constructed low-energy consumption houses are designed in a different way than the northern ones. Ancient rural houses were thermally protected

not only thanks to the appropriate location and simple architecture but also thanks to the small area of windows through which significant heat losses occur.

Nowadays, there is no such limitation. One can build low-energy consumption houses which simultaneously are fitted with glass in an optimal way and opened to the surroundings. Thanks to panes with advantageous ability of thermal insulation, reducing the heat loss from the inside as well as increasing the solar radiation permeability, it is possible to make an elevation with large glazed areas. It also enables creating rural architecture with new features and new aesthetic expression, moving with the times.

Not only is the beauty of ancient houses more often appreciated, but also the solutions, developed by our ancestors which now contribute to the thermal protection of buildings. This can be an inspiration prompting traditions in the future design of modern rural houses. These solutions have been known for ages, but only the technological development of our times allows us to implement them in a more perfect way. The architecture of the low-energy consumption buildings changes mainly thanks to the possibilities of new techniques in building construction, often even thanks to electronic equipment. The modern building should be the object containing the elements of rational solutions known from history combined with the elements of modern knowledge and technology. Hence, it is essential to combine the knowledge of our ancestors with modern technological achievements. Currently we strive to gain full control over environmental factors and convert them in a way which is most rational from the energy-saving point of view, so that, along with the building's installations, they constitute an interior microclimate adapted to the users' needs. The culmination of the quests for the highest possible effectiveness of the dwelling settlements, considering respect for energy, is the low-energy consumption architecture which is a synthesis of the best solutions developed across time [18].

The buildings erected at the beginning of the 20th century in Karwieńskie Błota are especially noteworthy. They are characterized by regional timber framing construction, half-hip roofs, often covered by reed. Some of them use passive heating system thanks to glazing of the southern elevations and optimal positioning of the buildings towards the sun. It is only one of few enclaves in northern Cassubia where architectural aesthetics still continue, the aesthetics which retain advantages of the regional architecture with the use of traditional and modern solutions of the buildings' thermal protection (Fig. 6).



Figure 6. Selected examples of contemporary buildings referring to the traditional solutions in Cassubian huts – dwelling houses, Karwieńskie Błota (photos by M. Górecka)

4. SUMMARY

The analyzed architectural elements, resulting i.a. from the specific climate and geographical conditions of northern Cassubia, distinguish this region from the other ones in Poland and speak for the thermal protection of buildings. To these elements, above all, belong:

1. Solid, rectangular plans of houses, advantageous from the point of view of thermal protection. A more elongated plan predominated in southern Poland and resulted mainly from a one-bay layout.
2. The significant protruding of roof eaves (equipped with wind beams), reaching 80 cm and protecting external walls and an entrance zone against the negative influence of atmospheric conditions. Larger eaves were found only in the Beskids and Podhale.
3. Large cubature of the attic of a half-hip roof playing the role of a thermal buffer of the ground floor and the upper protection of gable walls. A hip roof or gable roof with smaller cubature of space under the roof ridge predominated in southern Poland and in some central regions (the hip roofs have survived for the longest time in Lesser Poland, Podlasie, and in some regions of Mazovia, the gable

roofs were characteristic mainly in Podhale and the Beskids).

4. The two-bay layout, improving thermal and insulating properties of the object. The two-bay layout predominated in southern and south-eastern regions of Poland as well as in some parts of the central ones; a transitional system – one-and-half-bay layout – consisted of rooms with different heights, was found in the mountain and sub-mountain regions.
5. The concentration of the kitchen and heating facilities (in the central part of the house) having high accumulation properties and distributing heat evenly. In the buildings of the remaining parts of Poland, for example in the Mazovian huts, the chimney chambers were usually a bit narrower than those occurring in northern Poland.
6. Application of timber framing, characterized by heat accumulation properties and savings in lumber (this type of construction was characteristic also for western regions of Poland, Żuławy and Greater Poland). In the central and southern parts of Poland, the solid wooden walls of the log system predominated (Lesser Poland and Podlasie are the regions where it has survived in the pure form for the longest time).

The analysis of individual elements of folk architecture – starting from the shaping of the building mass,

through the rooms' layout, structural elements, heating facilities, to the very localization of a building on the plot and concept of surroundings – allows to state that the society of that time used all accessible means to preserve heat in buildings as best as it was possible. The creative thought of the constructors is visible especially in the constructive logistics, a response to local climate conditions simultaneously affecting the regional character of rural houses. Surely in many cases these objects can be an inspiration in quests for low-energy consumption solutions during the design of modern houses in rural areas.

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